Improving University Science Teaching and Learning

Pedagogical Projects 2012

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This is number one in the fifth volume in a series of publications of educational development projects made by participants in the teacher development course for assistant professors and post-docs held by the Department of Science Education, University of Copenhagen.

The aim of the series is to provide insight into the kinds of educational tasks and problems new teachers are facing, and to show how they manage them in inspiring ways.

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Preface

Lars Ulriksen and Jan Sølberg

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In 1993, it became an official requirement that in order to be qualified for the position of associate professor at any Danish higher education institution the applicant should have a "positive evaluation" of his or her pedagogical qualifications, as it was expressed. This sparked the institutions to initiate training or competence development programmes. While the establishment of programmes was slow in the beginning, not least getting participants for the courses, by the turn of the millennium there seemed to have emerged a framework for programmes that could be recognised across different institutions and the number of participants had risen. The framework consisted of course days combined with supervision in real-life teaching situations and frequently some kind of final development work or project. In the present set of regulations from 2007 it is stipulated that assistant professors should be provided with supervision and opportunities for the development of their pedagogical competences.

It has been a hallmark of most of the programmes to seek a close connection between the courses and the participants' own teaching experiences and practices. This is also the case for the programme at the science related departments and faculties at the University of Copenhagen that for some years have had a shared teacher development programme known as *adjunktpædagogikum* and by the Danish abbreviation KNUD (*Kursus i Naturfaglig Universitetspædagogik og Didaktik*) or the Teaching and Learning in Higher Education programme (TLHE). The duration of the programme is 175 hours and it spans one academic year.

An important part of the TLHE is the final project where the participants define a problem or challenge related to their own teaching practice

that they would like to change or otherwise investigate through experimentation. The projects, therefore, link to the actual teaching of the teachers and represent the challenges and experiences of university teaching. As such, the projects offer insights into the concerns, challenges, and possibilities of teachers at a Danish university working with science.

The present volume, the fifth in the series of collections of TLHE projects, presents a diverse range of teaching interventions and reflections on how to improve student learning. They show how teachers work to develop their individual teaching capabilities. Their work is informed by research in higher education teaching and learning, their own experiences, inquiries into the interests and conditions of the students, and evaluations of their own experiments. The contributions (as in the previous volumes), thus, remind us of what can be achieved within the present conditions and frameworks for planning learning activities for the students.

At the same time, they also draw attention to the fact that in order to improve students' learning experiences it does not suffice to change the teaching of the individual teachers in isolated classes. Some changes need to be addressed at the level of the course, others through coordination between courses, and others still through adjustments of the educational programmes. Improving teaching and learning at university sometimes requires changes across these different levels but the TLHE projects demonstrate how much it is possible to achieve even within the existing frameworks.

The present volume has been structured into five thematic sections.

The first, *Planning, designing, or redesigning units, courses or programmes*, is comprised of papers that focus on the development of teaching activities in particular courses. The focus is on improving the quality of the students' learning experiences through implementation of particular changes in the modules.

Johan Öinert takes as his point of departure the challenges a lecturer in mathematics experiences in teaching mathematics to first-year students. Öinert lists and comments on thirty points for a lecturer to consider based on seven interviews with experienced and popular mathematics lecturers from one Danish and one Swedish university. The points concern the importance of, for example, relating to the students, selecting content in order not to include too much, the structure of the lecture and the presentation of the material.

The project of Jonas Thue Treebak examines the motivation and study strategies of second-year undergraduate students attending a course on

work physiology at the Department of Exercise and Sports Sciences. He studied the motivation of students towards adopting a surface or deep learning strategy and the strategy the students actually apply. Through a number of changes in the teaching and learning activities at the course, he sought to encourage the students to adopt a deep learning strategy. After the course, he compared the study strategies adopted by the students with their evaluation of the course. He concludes that most students of the course adopted a deep learning strategy, but that those students who showed a more surface oriented approach tended to do so without being motivated for doing it.

Mikkel B. Thygesen's project deals with the development of laboratory exercises that are part of a bachelor degree course in Organic Chemistry. While the theoretical part of the course had received positive evaluations in the previous years, the evaluations of the laboratory exercises were more negative. Different measures were introduced to improve student motivation and deep learning. The measures included a more open and flexible structure of the course and short discussion sessions with individual groups. Overall, the measures increased the quality of students' learning approaches.

Susanne Pors' project deals with a bachelor degree course in a veterinary study programme that had recently been thoroughly revised. Following these changes the failure rate had increased significantly. The reasons for this increase presumably lay at the structural level, that is to say, beyond the control of the individual teacher. Nevertheless, Pors attempted to increase student motivation, student learning, and the students' awareness of their learning outcome. By introducing a student activity involving formative evaluation of a quiz related to the course content, Susanne Pors did indeed raise students' motivation and their awareness of their understanding of the course content. Furthermore, their responses also informed the teachers about particular difficulties the students encountered.

The second section, *Evaluating and revising courses or units – course development*, contains papers concerning the evaluation and discussion of present course designs including suggestions for course improvement.

The project by Henning Osholm Sørensen concerns some of the difficulties related to planning an experimental course involving many different lecturers. Another core issue relates to the students being involved in experimental group projects that they design themselves. This presents additional difficulties in the planning of the course, because it is impossible to predict exactly which techniques the students will choose to work with. Based on student evaluations from previous years, interviews with participating stu-

dents, and discussions with other teachers on the course, Sørensen presents reflections and suggestions as to how the challenges of the course might be addressed.

Camilla Trab Damsgaard reports on a project about the revision and evaluation of the oral exam in conjunction with the course "Public Health Nutrition". She identified key problems with the existing exam format by involving co-teachers in semi-structured group discussions about student evaluations, course coverage, exam questions and format, student learning outcomes and course alignment. Inspired by research on professional learning communities, Damsgaard thereby engaged co-teachers actively in the development process.

Anne Estrup Olesen's project concerns developing tutorials for the Pharmaceutical programme with a particular emphasis on the students' expectations and preparation before class. Based on feedback from peer-supervision and on experiments carried out in the two subsequent classes, Anne Estrup Olesen concludes that it is highly important to align students' expectations with those of the teacher. Further, too much time was spent on technical skills that were only moderately relevant to the overall learning objectives. She suggests that engaging the students in peer-teaching could increase student activity and responsibility.

The project of Aasa Feragen is about how to encourage computer science students to engage in self-directed learning activities outside the classroom. While implementing two different teaching strategies (case-based teaching and weekly assignments), Feragen investigated the students' outcomes through focus-group interview, questionnaires, course evaluations and discussions with other teachers. She finds that while the first strategy did not have the desired effect, the students found the teaching format meaningful. The second strategy however, was very effective in stimulating the students.

The third part, *Stimulating student activity and deep learning*, presents papers that emphasise the development of students' active participation in the teaching as a way to increase student learning and to achieve a learning experience with more focus on deep learning approaches. Both these principles are central to the TLHE course.

Jannie Olsen's project aims at increasing the students' active participation in lectures at a first-year bachelor degree course on natural resources and thereby stimulating a deeper learning approach. To achieve this, Olsen introduced a number of different activities in class, including small exercises, small-group discussions during the lecture, and a more dialogue-

oriented teaching style. Through the five lectures, Olsen adjusted her teaching and activities in response to the students' reactions and engagement in teaching.

Kasper D. Rand's project concerns the introduction and teaching of a new discipline to students of the pharmaceutical sciences. The project reports from three initiatives of different scales and educational levels. One was the introduction of quizzes and student activities on a PhD course. Another was the implementation of changes in laboratory exercises at bachelor degree level including preparing the students better and emphasising real-world relevance. The third initiative concerned the development of an entirely new course at master's degree level that should be a practical course building on Rand's experiences from the second initiative in the project.

Leise Riber's project concerns the development of the lecture format by introducing teaching activities that would allow students to engage with problems related to real-life cases and engage students in discussions of both closed and open questions. Based on a careful discussion of the students' evaluation of the activities Riber concludes that the activities were successful in enhancing the learning outcome. Also, most of the students indicated an increased level of engagement. However, the evaluations also suggest that there are important variations in the students' experiences.

In their project, Mette Boyd and Jette Bornholt Lange experimented with different ways of organising the teaching and learning activities at three different course days on a master's-level course in Bioinformatics. On the first day, the teaching would primarily be lecturing interspersed with shorter student activities, while on the second day there was a thirty-minute introduction in a lecture format followed by students working in groups on a case-like assignment. On the third day, students would work in groups preparing presentations to be held to the class. The experiments were evaluated by students, by the teacher, and by the other teacher observing the activities.

Oliver Bühler examines the course "Plants and climate in urban areas" in order to develop teaching materials and field exercises and to describe the challenges and resources pertaining to the course. In doing this, he hopes to achieve more "blended learning" wherein students obtain knowledge through self-guided activities in addition to more traditional teaching activities. Using both questionnaires and group interviews, he finds that memorising plant names is a big challenge for the students and that repetition is required to learn this. Several of the class activities, field trips the students take as part of the course and the exam seem to help achieve memo-

risation, but only under certain conditions. Bühler captures these conditions and uses them to formulate suggestions for future course improvements.

Poul Martin Bendix examines the benefits of research-like activities (research-based project work, paper presentations, and talks by guest researchers) for student perception of difficulty, inspirational value and student learning. Through the use of a questionnaire developed for the project, he finds that the students responded well to all activities, although the use of guest lecturers was determined to be less effective in promoting student learning. His project includes many relevant references to science education literature and concepts.

The fourth section, *Supervision and supervision styles*, consists of two papers addressing the particular teaching format of supervision. Supervision may not appear to be the most common form of teaching, but, as one TLHE participant noted, many assistant professors and postdocs are faced with many supervisory assignments – especially during their early careers.

Nicolas Rapin has written an innovative project aimed at uncovering emotional patterns in the e-mail communication between PhD students/postdocs and their supervisors. Using word mining in almost 200,000 e-mails, he discovers a mixed picture of the interactions which indicates that while e-mails may play an important role for supervision, lack of face-to-face communication can lead to confusion and depression among the people involved.

Peter Bentsen has written a project about meta-communication of supervision and the different supervisor roles in conjunction with supervision of master's degree students. He plans and carries out an educational experiment based on extensive research literature and user-driven innovation. The project challenges existing supervision formats by introducing a role-play situation where the student chooses a type-cast role for the supervisor as a final part of the session (e.g. the coach, mother, critical reviewer).

Finally, the fifth section, *Course structure analysis – constructive alignment*, presents three papers that address another key concept of the course: constructive alignment. This concept, drawing on the work of John Biggs, highlights the importance of aligning the intended learning outcomes, the teaching and learning activities the students are invited to engage in, and the form and content of the assessment.

Marianne Foss Achiam has conducted a course re-design aimed at addressing disconnects between theory and practice in an academic museum studies course. The project includes field research involving a survey sent to twenty-six informal science dissemination institutions as well as an anal-

ysis of student conceptual change using series of concept maps. Marianne Foss Achiam used the former to make informed changes to the course *Museumsformidling*, and the latter to evaluate the impact of these changes on the students' conceptual understanding. Her project concludes that the course changes improved student satisfaction and managed to lessen the gap between theory and practice.

Christian Pilegaard Hansen's project addresses the constructive alignment of an interdisciplinary master's degree course with a highly diverse group of students. Based on an analysis carried out in the pre-project he suggests changes in both the formulation of the intended learning outcomes and of the teaching and learning activities. Notably, the learning outcomes are changed to higher levels of the SOLO taxonomy and it is recommended that parts of the lectures are replaced by group work on exercises. Further, the consequences of the diversity of the participating students are discussed.

Lise Charlotte Berg has written about the alignment and subsequent improvements made to the "Basic Histology" course. Using student and teacher evaluations, exam results and personal reflections and experiences, as well as the experiences of veteran teachers of the course, Berg analysed course elements for internal consistency and possibilities for optimisation. Subsequently, she and a group of co-teachers made or suggested improvements to the course description, the use of intended learning outcomes, teaching and learning activities and course exam questions in order to achieve better alignment between them.

The papers in the present volume offer substantial variety in many ways. We are pleased to be able to share the reflections and experiences of the contributors, and we hope they may serve as inspiration for other higher education teachers – the novices as well as the experienced.

Part I

Planning, designing or redesigning units, courses or programmes

1

Planning and implementing mathematics lectures for first-year university students – tips and tricks

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The present manuscript, is based on the author's pedagogical project report written in July 2012 in the scope of Adjunktpædagogikum, which is a one-year long Teaching and Learning in Higher Education programme for assistant professors and postdocs, organized by the Department of Science Education, Faculty of Science, University of Copenhagen in the academic year 2011-2012.

Introduction

As a lecturer in mathematics for first-year university students one faces several challenging problems.

- Big classes: Many lectures are attended by nearly 200 students, and sometimes even more. This makes it difficult to reach out to individual members of the class and activate and motivate everyone.
- Low motivation: When lecturing for mathematics students, this is not a big problem, but basic mathematics courses are often mandatory in many educational programmes. This means that a lot of students have to take mathematics courses even if they do not really want to.
- High level of abstraction: Most people find university mathematics quite abstract. Nowadays, there are different ways of visualizing examples and certain mathematical concepts by using tools such as projectors and computer software. However, there are of course limits to what is possible, and to many people mathematics remains abstract.

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The first problem is not present to the same extent during exercise sessions (i.e. problem solving classes). The second problem is connected to the role that mathematics currently has in many educational programmes in engineering and natural sciences. The third problem lies in the nature of mathematics.

This project report is mainly concerned with methods and approaches that will activate and motivate students during mathematics lectures. Based on interviews with seven experienced, award-winning and popular mathematics lecturers from Lund University and the University of Copenhagen, we have compiled a toolbox of tips and tricks. The purpose of doing this, is that we believe that it will be useful to anyone (including the present author) who is trying to develop and refine his or her lecturing skills. Many of the tips and tricks can be applied to more general situations and are therefore not limited to mathematics lectures.

Tips and tricks

As a lecturer it is important that to develop a teaching style of your own, that you feel comfortable with. No one is born to be a good or a bad lecturer. By constantly training and reflecting over your work, you will be able to improve your lecturing skills and become an appreciated lecturer.

The list[3] of tips and tricks below is not intended as a template of matters that any good lecturer needs to take into account, but rather as a buffet of themes and ideas that might serve as a good basis and an inspiration for self-reflection.

Golden rules

We begin by presenting some important general principles.

Tip 1: The real golden rule

You should always ask yourself: If I were a student attending my own lecture, what type of presentation would I like to see?

[3] Many of the tips and tricks are closely related, and in some cases there is even some overlap. This has been difficult to avoid.

Tip 2: Preparation, preparation, preparation

As a lecturer you have to exhibit self-confidence and there is simply no room for hesitation. Therefore, it is crucial that you are extremely well-prepared.

During the interviews it became clear that one thing that all interviewees had in common, was that they are always very well-prepared before every lecture. Perhaps this is the most important piece of advice in the list.

One interviewee said:

> I am always extremely well-prepared. At the moment my lectures begin at 8:15. I typically wake up at 6:30 and between 6:30-7:00, before I have breakfast, I read through my lecture notes. If I have an afternoon lecture, I also spend 30 minutes reading through the lecture notes.

Another said:

> After having planned a lecture, I typically prepare myself twice. The first time, I think about what I am going to say. The second time, I think about how I am going to say it.

Tip 3: Never go over time

It is very important to stop on (or before) time. To go over time is not only impolite, it might even be useless. For example, if a lecture is supposed to end at 12:00, then anything that is being said after 12:00 is likely to fall outside of the students' attention span.

Tip 4: There are no stupid questions

In order to encourage the students to ask questions and to take active part in your course, it is of great importance that they feel welcome to do so. Therefore, one should never under any circumstances do anything that could give a student the feeling that you think that he or she is stupid. A rule of thumb that one should bear in mind: There are NO stupid questions! Even if you think that a student asks a crazy question, you must not let it show! Always be polite and treat any question as if it were the most interesting one you had ever heard.

One interviewee said:

> If you get a strange or stupid question in the lecture hall, then it might just be that 30 out of 100 students are asking themselves the same question. Therefore one has to take every question seriously!

Tip 5: The tone of your voice

A monotonous voice can easily make the students feel less motivated and eventually sleepy. You should try to talk loudly, with a variation in both pitch and intensity, in order to avoid monotonicity. And remember never to mumble!

One interviewee described himself:

> I am pretty intense. I talk loud and fast and move a lot. I run back and forth in front of the blackboards. All together, I think that this helps to maintain the attention of the students.

Tip 6: Show that you care

If you show the students that you genuinely care about their learning, then they are far more likely to actually learn something. Let the students see that you enjoy explaining mathematics to them. It will make your job easier and the students will appreciate it!

Tip 7: Memorize the names of your students

If you have a good memory, it is probably worth investing some time on this. This will also make the students feel that you care about them.

The role of the lecturer

Tip 8: Let your enthusiasm and passion shine through

Do you want the students to think that mathematics is fun and interesting? Then you have to let them know that you feel the same way. Therefore it is important that you always show a great deal of enthusiasm during your lectures. Things that you find trivial, and perhaps not very exciting, can still become exciting for the students if you give them the impression that it is exciting to you. This may sometimes require some good acting skills on your part, but it will be worth it because enthusiasm is contagious!

One interviewee said:

> In the beginning, I thought that the most important thing was to present the material in a structured and logical way. While it is still very important, I have learnt that it is far more important to make the students excited and interested!

Tip 9: Establish a good atmosphere during the first week

If you work hard during the first week of your course, to create a good atmosphere in the class, then everything becomes much easier from that week on. A friendly atmosphere should make the students feel at home so that they feel that they are always welcome to ask questions for example. In fact, under optimal circumstances they will even be inclined to ask questions.

One interviewee cautioned:

> The students may say that they genuinely enjoy your lectures, but that does not necessarily mean that they are learning mathematics. This is something that one needs to be aware of! It might be a good idea to throw out some control questions once in a while.

Tip 10: Earn the trust and respect of your students

In order to earn the trust and respect of your students, you should of course act like a decent person and be friendly and show respect for them. On a more professional level, you need to explain to the students, for example, why complex numbers are useful and why one needs to be able to solve a differential equation. It is crucial that the students get an idea of why they are supposed to learn what we want them to learn. If you do this successfully, the students will eventually trust you and teaching them new material will be easier.

Tip 11: Use your authority

When you stand in front of the blackboard, you should never challenge yourself, for example by indicating that your method or approach may not be the best one. You should never show hesitation or come across as indecisive in the lecture hall. Remember that the students have come to listen to YOU and that they thereby have given you the mandate to tell them what you want! When you meet students in smaller groups, you should of course be more humble. But in the lecture room, you are the one in charge.

The structure of a lecture

Tip 12: Explain the purpose and the goals

Whenever you begin a new lecture or introduce a new concept, it is of great importance that you carefully explain the purpose. If not, the students

might easily lose interest. Therefore, it is a good idea to start every lecture by explaining what you want to do today and why it is important. One could for example write down a menu of what today's lecture looks like. This will add to the excitement. (Some lecturers go so far as to write down time estimates on what time they will arrive at different sections of the programme.) You should strive to explain how your mathematics course fits into a bigger picture. At the beginning of a lecture, it is important to formulate a good question which seems natural and important enough to want to find an answer to, and which the students can think about. Why? Explain to the students!

A related tip is the following:

Tip 13: Always anchor your ideas in the class

If you want to try new approaches, for example new pedagogical ideas, always make sure that you explain the purpose to the students and ask them what they think. If the students do not show their consent, it is possible that you will experience major difficulties later on.

Tip 14: Interrupt the flow

The attention span of the students is quite limited. If you talk for too long, then eventually you will have lost the attention of most of the class. Therefore it is sometimes a good idea to make (informal) pauses once in a while, just in order to create a discontinuity that will stop the flow of information. It then becomes natural to allow for the students to ask questions. One could also for example tell a joke, describe a curiosity or display a funny example – anything in order to break the flow. By doing this, for example, every 20 minutes, the brains of the students will have the opportunity to relax for a minute or two, after which they will be ready for another session of 20 minutes.

Tip 15: Do something unexpected, if necessary

As a lecturer you can quickly tell if the students are listening to you or not. All you need to do is to take a look across the lecture hall. If you notice that some students are being unfocused, are losing attention or – even worse – are sleeping, then you immediately need to take action. Sometimes you need to do something strange or unexpected, in order to regain their attention.

Presentation of the material

One interviewee said:

> There is a good reason for presenting our (mathematics) lectures mainly on blackboards – it makes the presentation slow enough for people to have time to think about what is actually being said. A PowerPoint presentation does not give the same impression.

Tip 16: How to handle the blackboard

This advice might seem unnecessary, but it needs to be mentioned. You should always begin writing at the top left blackboard. Use the boards carefully and think through in what order you want to use them. Step aside, in order not to block the sight of your students. Try to avoid speaking into the blackboard while you are writing. Instead, turn around, talk to the students while looking them in their eyes and let them feel your presence!

One interviewee said:

> I pay a lot of attention to the presentation of the lectures on the blackboards. I use different colours and try to make definitions and theorems appear in a certain way. I am thinking that when they write (copy and paste) this down into their notebooks, I want it to look almost like a book.

Tip 17: Grouping the blackboards together

When you are in a big lecture hall you might even divide the blackboards into different groups. For example, you could use some of the blackboards to demonstrate examples and some of the blackboards to make calculations. By doing this, the students will see when some change is about to occur, that is when you walk from one group of blackboards to the next.

Tip 18: Create some drama around a mystery

A couple of the interviewees compared the flow of a lecture to the dramaturgy of a movie. They start by describing some part of the theory or an example as a mystery that needs to be solved. One could even announce it as the mystery of today. During the lecture they try to build up tension and drama, and under optimal circumstances, the mystery is resolved just in time for a break or the end of the lecture. This requires a lot of preparation and planning, but if made properly it will be an important way of keeping the students excited and motivated during the lecture.

Tip 19: Less is more

A common mistake is to try to fit too much material into one lecture. A rule of thumb is to always include the material that is needed to proceed with the rest of the theory, but not more. One interviewee described that for a 2x45 minutes lecture, he only plans for 2x40 minutes of lecturing, in order to leave some room for questions. Another interviewee described that she always tries to choose three or four essential things that she thinks that the students should understand before the lecture is over, and then her focus will stay on those things. Essentially, the students will not be able to remember everything that you say. If you choose some topics and handle them with care, then hopefully the students will understand and remember them better. This might lead them to wanting to find out more from the textbook. Another rule of thumb is that: Quality is always better than quantity.

One interviewee said:

> Knowing how difficult it is for many students to stay focused, you might want to end the lecture by saying something along the lines of "If you don't remember everything, at least try to remember ... this and that."

The following tip is closely related to the one above.

Tip 20: No stress

Stress resulting from the feeling of not being able to cover the material that one wanted to fit into one lecture, is common. There is no reason to feel stressed about this. You should make sure that the things that you do say, are being said well. Remember that your job as a lecturer is to tell a story that will help the students to find a red thread and navigate through the material of the course. For example, you might not want to spend too much time giving full proofs, but instead refer the students to the textbook. You have to make sure that you explain this to the students at the beginning of the course.

Tip 21: Tell a funny story

When presenting some new material that has some important historical connection, it might be appropriate to tell a funny story or to mention some curious facts or historical anecdotes. This will allow for more interest to arise.

Remember that your lecture should be pleasant to watch and listen to. By displaying the historical relevance of things that you are about to say, it will also create more excitement.

Tip 22: Repetition

The students tend to forget details if they do not see any immediate use made of them. Therefore it can be a good idea to repeat some of the main concepts during subsequent lectures. If they hear something two or three times, it is more likely to stick. This should of course only be applied to the most central concepts.

Tip 23: Get textbooks from parallel courses

Consult textbooks that the students use in the courses running in parallel to your mathematics course. Just by browsing through them, you will get an idea of what type of mathematics (if any!) is being used in those courses. If there is any connection between the mathematics that you teach, and what is being used in the parallel courses, it should be pointed out to the students. By explaining such connections, you will show them the position that your course has within their educational programme. Thereby, your course will seem more relevant and the students will hopefully become more motivated.

Tip 24: No farfetched examples

Never use any farfetched or artificial examples. The use of unnecessary or irrelevant examples can easily come across as strained, and the students will soon see through it. Remember that most of your students come to your lectures to learn how to better understand mathematical concepts. If you can find suitable examples (from adjacent areas such as physics) that will help to illuminate mathematical concepts, then they might be useful and valuable. Otherwise, leave them out!

Tip 25: Finding the right level

To find an appropriate level for the presentation in a lecture is always difficult. A lecture will always be a compromise; there will be some students

that find the presentation too hard, and some students that find it too easy. One should aim at placing the level somewhere close to the average. However, keep in mind that there is no such thing as a too simple explanation.

Tip 26: Online lecture notes

Scan your lecture notes and post them onto the course homepage before your lecture. This has several advantages. The students will be able to print them or read them from their e-readers, and then not feel the need for taking notes of their own. This creates an opportunity for the students to try to follow what is being said in the lecture and not drown in their own notebooks. Another advantage is that if you find yourself in a situation where you are running out of time, you could easily refer the students to your lecture notes and simply skip things that are not of immediate importance. Obviously, the use of such lecture notes is optional and the students will of course still be able to write their own notes if they prefer to do so.

One interviewee explained:

> I want the students to listen to me and stop focusing on writing everything down. They should be able to relax and really listen carefully to what I have to say.

Another one said:

> There is a great danger with mathematics students going to a lecture and taking notes, thinking that they are being active, when they are in fact passive! They need to listen and wait for questions to arise within their heads.

Some lecturers are critical of posting lecture notes online, one argument being that most undergraduate courses are based on a textbook which is usually much better written than any set of lecture notes. However, a set of lecture notes, of course, gives an opportunity to give alternative explanations that are not to be found in the textbook.

Tip 27: Using pencasts

Using a special type of smart pen (from LiveScribe) one can create so called pencasts. The pen is equipped with a laser reader and a microphone. By writing your notes on a special type of paper and simultaneously recording your voice, a video is generated. When watching the video, the students

will see how the things you write gradually grow in front of their eyes as they hear your explanation. This is a very powerful method. By placing such videos on the course homepage, you are able to explain some things in much more detail than you have time for during a lecture. Moreover, the students will be able to hit the pause button which is sometimes necessary in order to have time to think, but which is not possible during a lecture.

The goal should not be to put all of the lecture notes as pencasts on the course webpage, but certain concepts that are central and that might need more explanation, could easily be provided in this way.

One interviewee said:

> Once, in a course of 200 students, I had a single pencast-video that was viewed 1000 times.

Visualization aids

In addition to drawing on the blackboard, there are several aids that one can use.

Tip 28: Document camera

By placing an object in a document camera, one can immediately project an image of the object onto the wall. It is possible, for example, to display anything from the screen of a mobile phone, or a paper or even some bricks of Lego. More concretely, it is very useful if one wants to display something from the textbook. If you have a smartphone, then it will certainly be able to produce function graphs. Hence, you could display function graphs without bringing a computer. One interviewee explained how he explains Riemann sums when teaching integration of functions

$$\mathbb{R}^2 \to \mathbb{R}$$

using Lego and a document camera. (Fig. 1.1).

Tip 29: Maple software

If you are good at drawing 3D pictures, then you can do it by hand on the board. Otherwise, it is an excellent idea to use the computer software Maple to create 3D images. One can also create animations.

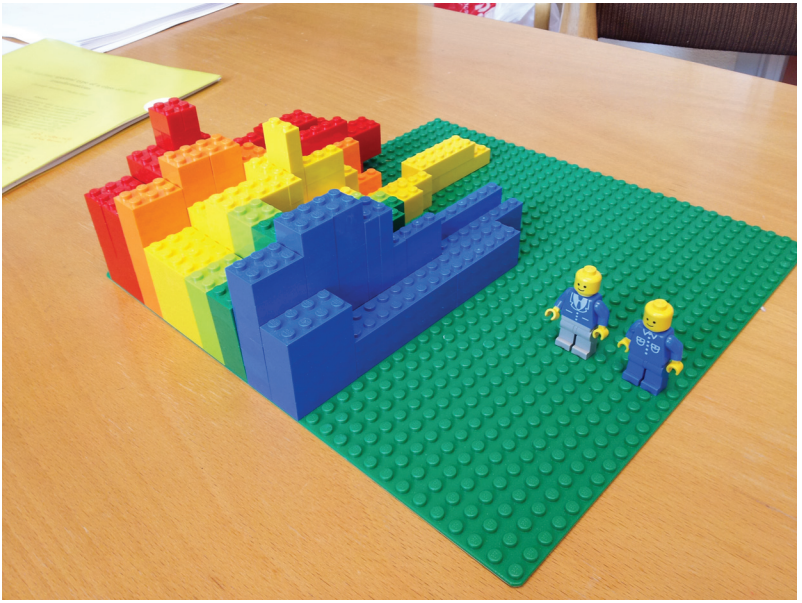

Fig. 1.1. Using lego bricks to explain Riemann-sums. N.B.: The lego men are supposed to be Riemann respectively Lebesgue.

Tip 30: Videos

In some situations playing a video can create a lot of excitement among the students. For example, a video of the collapse of the Tacoma Bridge can serve as a motivation when discussing eigen frequency.

Discussion

As mentioned in the section "Tips and tricks" above, the list of tips and tricks is intended as a buffet of themes and ideas that might serve as a good basis and inspiration for self-reflection for lecturers. The tips and suggestions from the interviewees overlapped with each other substantially, and the final list is the result of an interpretation and moulding process conducted by the present author. We think that each tip is valuable in its own right and deserves attention.

The approach taken by this report is very practical and, in the light of Biggs & Tang (2007), fits the description of the views of a level-2 teacher, i.e. a teacher who mainly focuses on what the teacher does. To ascend to level 3, i.e. to focus on what the student does and how the student actually learns during a lecture, is a gigantic undertaking, which would have required a massive investigation. (Remember that we are dealing with populations of approximately 200 students.) One has to keep in mind that a lecture is just one example of a situation when learning (hopefully) takes place. Typically, in the scope of a course, you also have exercise sessions, laboratory exercises, examination, homework, self-study, etc. The present author believes that only a small portion of learning actually takes place during mathematics lectures. It is later that the students are able to process what they heard and saw in the lecture. During exercise sessions and self-study sessions following a particular lecture is where the actual learning takes place.

> Mathematics is not a spectator sport. You can't expect to learn mathematics without doing mathematics, any more than you could learn to swim without getting in the water.

In the beginning of his book, Hungerford (1996) makes the above statement to emphasize the importance of doing exercises, and I fully agree with this opinion. Nevertheless, lectures represent an important channel for introducing concepts and ideas, preparing the students for other learning activities and giving them a natural platform for asking questions. Another important role of lectures is to function as a source of inspiration for the students (compare this to Gibbs (1981)).

The current typical lecture format for mathematics lectures for first-year university students does not encourage students to do much actual mathematics during the lectures; they mainly listen passively and occasionally ask questions.

In fact, it is natural to ask if our current way of lecturing in mathematics could be made more efficient. This is why, at the end of each interview, the opinions and teaching methods (e.g. conceptual challenges) of Mazur (1997), were explained to the interviewees and followed up with the following question: "Do you think that Eric Mazur's methods for physics lecturing also could be applied to mathematics lecturing for first-year students?"

Roughly half of the interviewees responded: "Maybe. Why not? We should try to find out!" The other half responded "Absolutely not!", their main objection being that it simply takes too much time. One has to realize

that teaching mathematics to first-year university students is a large-scale enterprise in many universities. We have a limited amount of time that needs to be used wisely and planned carefully. It could be that Mazur's methods are not suitable for all types of courses or mathematics students, but it is my belief that it at least needs to be further investigated by doing experiments, beginning on a small scale.

A The interviews

In total seven mathematics lecturers were interviewed; five at Lund University and two at the University of Copenhagen. They have all shown extraordinary skills when it comes to lecturing. Their experience as lecturers for first-year university students ranges from five to twenty-five years. The interviews where recorded with durations ranging from twenty-three to eighty-two minutes per interview. In total, the seven interviews took five hours and 13 minutes.

Interview template

Getting started and in general:

- Practical things; anonymity, recording, purpose of the project.
- Relevant data: How long have you been lecturing mathematics to first-year students at university level?
- As a new lecturer, what did you think of as the biggest challenge with the teaching situation lecture?
- What lessons have you learnt during your time as a lecturer? Please be concrete.
- Today, what do you see as the biggest challenge in your role as a lecturer? Do you actively take any measures to affect or prevent this?

Before the lecture:

- Do you have any trick to make the students prepare before the lecture?
- Do you have any trick to make the students actually come to the lecture?

During the lecture:

- Describe a typical lecture, which is given by you.
- What measures do you take in order to keep the students alert, active (participating) and motivated, curious and wanting to learn more?
- Do you have any practical tips and tricks or examples of games that one could use?
- Do you use any kind of visualization aids?
- The ideas of Eric Mazur's is explained to the interviewee. Follow up question: Do you think that Eric Mazur's teaching methods for physics lecturing also could be applied to mathematics lecturing for first-year students?

2

Effekter af dyb læringstilgang på studerende med overflade og dyb tilgang til læring

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Indledning

Motivation til læring skabes ved at stimulere den enkeltes nysgerrighed og opmærksomhed over for et specifikt emne. At optimere læringsprocessen kræver tankefuld planlægning af undervisning og involvering af den studerende, idet viden bør konstrueres af den, der undervises (Biggs & Tang 2007). Dette indebærer blandt andet udvælgelse af rette undervisningsformer og metodikker i forhold til at skabe et motiverende undervisningsmiljø. Flere studier viser f.eks. at en varieret og interaktionsbaseret undervisning fører til større aktiv deltagelse og indlæring (Mazur 1997, Trigwell et al. 1999).

Retning og intensitet, forstået som henholdsvis mål og den hastighed man bevæger sig mod målet, er centrale elementer i forståelsen af begrebet motivation. Underviseren har en særlig rolle i forbindelse med definition af læringsmål og bidrager også, via valg af metodikker og didaktiske overvejelser, til en styring af intensiteten. Studier viser at underviserens tilgang til faget har stor betydning for, hvordan studerende lærer faget. En strategi, hvor fokus er på den studerendes kompetencer og som er baseret på problemløsning, interaktion, diskussioner samt opstilling af klare mål, vil føre til en dybere indlæring hos den studerende, hvor det, der læres, konstrueres af den studerende selv (Biggs & Tang 2007).

Motivation har desuden to sider (Biggs & Tang 2007, Kissmeyer 2009); en ydre og en indre, og vi kan som undervisere styre begge sider. Ydre motivation stimuleres f.eks. gennem motiver, der bunder i en søgen efter anerkendelse (anerkendelsesmotiv) som ros og påskønnelse, eller motiver der

har et materielt sigte som det at erhverve sig personlige fordele eller belønning (materielle motiver). Ydre motivation er i forhold til læring befordrende i et vist omfang, men kan aldrig stå alene. Indre motivation derimod udspringer fra den, der skal lære, og opbygges og opretholdes gennem en stimulation af nysgerrigheden (nysgerrighedsmotiv) eller gennem fokus på præstationen (præstationsmotiv), forstået både som trangen til at forbedre egne resultater, men også frygten for ikke at slå til. I forhold til motivation for læring kan den indre motivation stå alene idet opmærksomheden rettes mod processen, og initiativet til læring er hos den studerende (Biggs & Tang 2007, Kissmeyer 2009). Med udgangspunkt i teorien om, hvordan man skaber et motiverende læringsmiljø, hvor man positivt stimulerer de studerendes indre motivation til læring, kan man opstille følgende centrale strategier:

- Tilrettelæg undervisningen med klart definerede læringsmål.
- Tilrettelæg undervisningen, så den stimulerer den studerendes nysgerrighed.
- Tilrettelæg undervisningen, så den studerende ønsker at dygtiggøre sig.
- Styrk den indre motivation ved at skabe rammer for succesoplevelser for den studerende.
- Styrk den indre motivation ved at have fokus på at den studerende føler sig kompetent.
- Styrk den indre motivation ved at lave undervisningen problemorienteret.

Problemafgrænsning og formål

Arbejdsfysiologi 4 afholdes for studerende på fjerde semester på Institut for Idræt. På dette kursus var der i forhold til beskrivelsen på SIS ikke særlig god overensstemmelse mellem mål, indhold og evalueringsform. Specielt var der en klar divergens mellem målbeskrivelsen og beskrivelsen af de kompetencer, de studerende skulle opnå under kurset. Hvor målbeskrivelsen anvendte ord som demonstrere, vurdere og analysere, som ligger relativt højt i Blooms taxonomi eller SOLO taxonomien, så var det lavere rangerende ord som beskrive, have kendskab til og forstå, der blev anvendt i kompetencebeskrivelsen. De studerende kunne derfor i teorien ikke opnå karakteren 12 med de kompetencer, de ville få i løbet af kurset, hvis de blev bedømt ud fra målbeskrivelsen. Da jeg læste mål- og kompetencebeskrivelser samt evalueringsformer for Arbejdsfysiologi 1-3, var det generelle billede at der for disse kurser heller ikke var specielt god overensstemmelse

mellem læringsmål, undervisningsform og evaluering. Det er således uklart for mig om studerende på idræt bliver ansporet til at anlægge en tilgang til faget, der giver overfladisk eller dyb læring, og dermed i hvor høj grad deres indre motivation for faget bliver stimuleret gennem uddannelsen. Da Arbejdsfysiologi 4 aldrig var blevet afholdt før, besluttede jeg mig for at forsøge at planlægge indholdet og undervisningsaktiviteterne således at de studerende blev i stand til at anvende den viden, vi undervisere formidlede således at de kunne analysere og vurdere komplekse fysiologiske sammenhænge. Ideen var således at forsøge at anspore til dyb læring og dermed at stimulere deres indre eller dybe motivation ved at tilrettelægge undervisningen efter strategien beskrevet i indledningen. Desuden var jeg interesseret i at undersøge, hvordan studerende, der har høj indre motivation for at studere og som ofte tager en dyb tilgang i forhold til læring, responderer på undervisning, der netop ansporer til dyb læring sammenlignet med studerende, der har en overfladetilgang til læring og som ikke har samme form for indre eller dybe motivation.

De overordnede formål med dette projekt var således:

1. at karakterisere de studerende på Arbejdsfysiologi 4 i forhold til deres læringsstrategier.
2. at sammenligne studerende med forskellig tilgang til læring i forhold til deres udbytte af et kursus, der ansporer til dyb læring.

Metode

Planlægning af Arbejdsfysiologi 4

Som nævnt ovenfor var min vision at de studerende skulle kunne anvende den viden, de fik på kurset til at analysere og vurdere komplekse fysiologiske sammenhænge. Jeg valgte derfor at planlægge kurset så de studerende havde en reel mulighed for at nå de konkrete mål beskrevet på SIS. Jeg havde følgende strategier i forhold til indholdet i undervisningsaktiviteterne for at opnå dette:

1. Jeg ville gøre forelæsningerne problem- og case-orienterede frem for facts-orienteret.
2. Undersøgelser har vist at evnen til at koncentrere sig under en forelæsning falder efter 15-20 minutter, hvis der ikke gøres noget aktivt for at opretholde fokus. Jeg ville undgå at miste fokus ved regelmæssigt

gennem lektionen at lave summe-opgaver, hvor de studerende fik lov at sidde i små grupper og diskutere et spørgsmål. Dette kunne f.eks. gøres via Socrative, hvor der også er mulighed for at lave multiple-choice opgaver, der tester forståelsen.

3. Jeg ville introducere en større case i slutningen af den sidste forelæsning før gruppetimerne, som de studerende skulle arbejde med indtil gruppetimerne.
4. Mellem forelæsninger og gruppetime ville jeg bede dem om at stille spørgsmål til emnet i et diskussionsforum i Absalon. På den måde kunne jeg få en idé om, hvor de havde forståelsesmæssige problemer, og de ville samtidig kunne hjælpe hinanden til at forstå pointerne.
5. Ved gruppetimerne planlagde jeg at give dem mindre problemløsningsopgaver og refleksionsspørgsmål, som de skulle løse i grupper og som derefter blev gennemgået i fællesskab.
6. Der var fine animationer til dele af pensum, der forklarede vigtige fysiologiske processer. Disse animationer ville jeg få de studerende til at forklare for hinanden.
7. I forhold til eksamen var det vigtigt at de studerende fik mulighed for at anvende den viden, de fik i løbet af kurset. Derfor ville jeg lade eksamen bestå af case-opgaver, der skulle teste de studerendes evne til at analysere og fortolke de komplekse fysiologiske sammenhænge, de stødte på i løbet af kurset. Jeg tænkte at ville tillade hjælpemidler til eksamen.

Udfordringen var at der var seks forskellige undervisere på kurset som skulle tage hver deres del. Så selvom jeg beskrev mine tanker omkring kurset for dem inden kursusstart, kunne jeg kun forsøge at strømline undervisningen efter mine ideer; jeg kunne ikke være sikker på at de andre undervisere valgte at undervise på den måde. Jeg forsøgte efter undervisningsforløbet var afsluttet at få underviserne til at skitsere, hvordan de havde undervist (Appendiks A), men kun halvdelen af underviserne responderede, så jeg har ikke et komplet overblik over hvordan undervisningen forløb. Jeg kunne dog følge med på Absalon og se hvilke forelæsningsnoter og opgaver, der blev lagt ud til de studerende. Dette gav mig et brugbart billede af undervisningsform og indhold.

Karakteristik af studerende på Arbejdsfysiologi 4

Jeg tog udgangspunkt i (Biggs et al. 2001), som har udviklet et spørgeskema, der giver mulighed for at undersøge studerendes tilgang til læring.

Biggs et al. (2001) skelner mellem deep approach og surface approach og deler yderligere de to tilgange op i motivation og strategy; se figur 2.1. Jeg oversatte spørgsmålene til dansk og bad de studerende på Arbejdsfysiologi 4 svare på dem (Appendiks B). Baseret på et prædefineret pointsystem kunne jeg få et kvantitativt mål for de studerendes motivation og tilgang til læring. Af de 48 tilmeldte studerende fik jeg svar fra 38.

Deep approach		Surface approach	
Deep motivation	Deep strategy	Surface motivation	Surface strategy

Figur 2.1. Opdeling af begreber efter Biggs et al. (2001)

Udover at spørgeskemaet kunne give mig indblik i den generelt foretrukne tilgang til læring hos idrætsstuderende på andet år, kunne jeg undersøge, om der var en sammenhæng mellem de studerendes motivation og den læringsstrategi, de anvendte. Ideen var at udvælge de studerende, som havde en udpræget dyb motivation for studiet og som har tillagt sig en udpræget dyb læringsstrategi. Disse ville jeg sammenligne med studerende, der overvejende havde en overflade motivation og som har tillagt sig en overflade læringsstrategi. De sammenligninger, jeg ønskede at lave, baserede sig på de svar, de studerende gav i forbindelse med evalueringen af Arbejdsfysiologi 4.

Evaluering af Arbejdsfysiologi 4

Efter kurset var overstået skrev jeg ud til de studerende og bad dem, via Absalon, tage stilling til en lang række udsagn om kursets undervisningsaktiviteter, om underviserne og om deres udbytte af kurset. Jeg tog udgangspunkt i det spørgeskema, som Wilson et al. (1997) har udviklet (Appendiks C), og som gav mulighed for kvantitativt at vurdere de studerendes svar. Spørgeskemaet er udviklet til at give et billede af en hel uddannelse, så jeg oversatte og omformulerede udsagnene, så de kunne bruges til mit formål. Ud af de 48 tilmeldte studerende fik jeg svar fra 26. Spørgeskemaet giver specifikt en vurdering af:

- Undervisernes rolle i forhold til at hjælpe de studerende gennem kurset.

- Om der var opsat klare mål.
- Om de studerende fik udviklet generelle færdigheder som f.eks. evnen til at strukturere deres læsning eller evnen til at kommunikere mundtligt og skriftligt.
- Evalueringsformen, der blev brugt undervejs i kurset.
- Om arbejdsmængden var passende.
- Om der var fokus på at udvikle selvstændighed.

Ud af de 38 studerende jeg fik svar fra på spørgeskemaet om læringstilgange (Appendiks B) udvalgte jeg ved hjælp af korrelationsanalyser, de seks studerende der fik den højeste deep approach-score og de seks studerende med den laveste deep approach-score. Svarene fra evalueringsskemaet (Appendiks C) fra disse 12 studerende blev sammenlignet for at undersøge, om der var forskel på de studerendes udbytte af Arbejdsfysiologi 4.

Resultater og diskussion

Planlægning af Arbejdsfysiologi 4

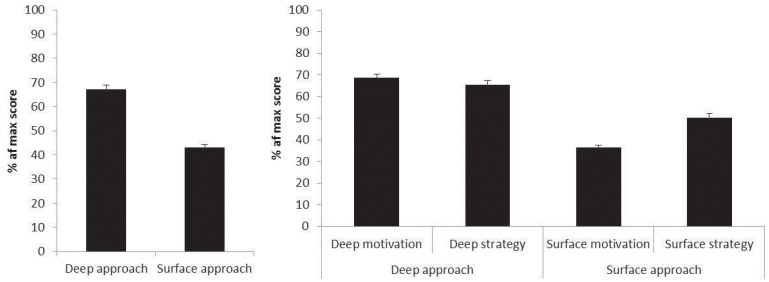
Jeg havde forudset at det kunne blive meget svært at få alle underviserne til at anvende samme undervisningsform i forhold til, hvad jeg havde planlagt. Det var dog min fornemmelse ud fra de præsentationer og opgaver, der blev lagt ud på Absalon at der til forelæsningerne var god vægtning mellem ren forelæsning og mere problemorienteret undervisning, hvor de studerende skulle arbejde selvstændigt. Ud fra de svar jeg fik fra tre af underviserne kunne jeg også se at der blev stillet relativt mange spørgsmål i forelæsningerne for at aktivere de studerende. Gruppetimerne forløb stort set, som jeg havde planlagt dem med gennemgang af en større case og gruppearbejde om mindre opgaver og animationer. To ting gik dog ikke som planlagt. Da jeg introducerede kurset havde jeg kraftigt opfordret de studerende til at stille spørgsmål i diskussionsforummet i Absalon. Det skulle give underviserne en idé om, hvor det var vigtigt at bruge tid for at højne forståelsen for stoffet, men der kom ikke eet spørgsmål under hele kurset. Set i bakspejlet kunne jeg have opfordret underviserne til at starte diskussioner, men hvorvidt de studerende ville bruge tid på sådan en aktivitet, er jeg selv tvivlende overfor. Det anden ting som ikke gik som planlagt var i forhold til eksamensformen. Jeg ville gerne have afholdt eksamen med hjælpemidler og således lave eksamenssættet, så det i højere grad testede deres forståelse

af stoffet fremfor at huske på facts fra pensum. Den måde eksamen er sammensat på har stor betydning for den tilgang, de studerende har i forhold til indlæring af stoffet (Biggs & Tang 2007). Mine kolleger var dog ikke enige i at en eksamensform med hjælpemidler var fordelagtig for studerende på dette sted i uddannelsen. De var bange for at det ville gå ud over eksamensresultatet, så eksamen blev gennemført uden hjælpemidler og kom til at bestå af 12 korte spørgsmål og en essayopgave. Overordnet var jeg tilfreds med den måde, kurset kom til at køre på og jeg mener at kursets undervisningsform og indhold kurset gør mig i stand til at besvare mine overordnede spørgsmål.

Karakteristik af studerende på Arbejdsfysiologi 4

Jeg var interesseret i at undersøge den generelle tilgang til læring hos andetårs idrætsstuderende. Ved gennemlæsning af SIS beskrivelserne af Arbejdsfysiologi 1-4 blev det ikke klart for mig, om den teoretiske del af uddannelsen ansporede de studerende til at anlægge en dyb eller overfladetilgang til læring; primært fordi der var dårlig overensstemmelse mellem læringsmål og kompetencebeskrivelserne for de enkelte fag. Ved at lade de studerende udfylde spørgeskemaet fra Biggs et al. (2001) kunne jeg danne mig et overblik over de studerendes foretrukne læringstilgang. Som det ses af figur 2.2A scorer de studerende generelt højt på spørgsmål, der afdækker, om de har en dyb tilgang til læring, hvorimod de scorer markant lavere på de spørgsmål, der afdækker, om de har en overfladetilgang til læring. Hvis man ser på, om den dybe tilgang skyldes deres motivation eller den læringsstrategi, de anvender, så scorer de stort set lige højt på de to parametre. Derimod er der klart forskel på de to parametre, når man ser på, hvordan scoren for overfladetilgangen er sammensat. De studerende ser ud til at tillægge en overfladestrategi uden i samme grad at være motiveret for det. Denne forskel kunne være et udtryk for at enkelte fag vælger at teste de studerende i paratviden, og at de derfor anspores til at anlægge en overfladestrategi. Generelt er den studerende på Arbejdsfysiologi 4 dog karakteriseret ved at anlægge en dyb fremfor overfladetilgang til læring. Men der er individuelle forskelle og ved at korrelere scorerne for de enkelte parametre, har jeg undersøgt, om det er muligt at udvælge studerende med udpræget dyb eller overfladetilgang til læring.

Via korrelationsanalyser undersøgte jeg data på kryds og tværs og fandt at der kun var to analyser der gav signifikante ($p<0,05$; $n=38$) korrelationer (Figur 2.3A og B). Der var en negativ korrelation mellem Deep motiva-



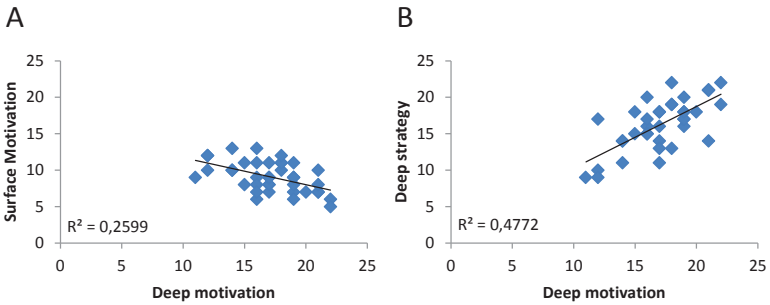
Figur 2.2. A. Karakteristik af studerende (n=38) på Arbejdsfysiologi 4 i forhold til læringstilgang (Biggs et al. 2001). De studerende ser ud til i højere grad at anvende en dyb tilgang fremfor en overfladetilgang. B. Deler man de to tilgange op i motivation og strategi ser man at begge komponenter bidrager lige meget i forhold til den dybe tilgang, mens de studerende til en hvis grad tillægger en overfladestrategi, men til gengæld er markant mindre overflademotiveret.

tion og Surface motivation, og der var en positiv korrelation mellem deep motivation og deep strategy. Med andre ord; jo højere den dybe motivation er hos de studerende, jo mindre er de overflademotiveret; og jo højere den dybe motivation er, jo mere anvender de en dyb strategi i forhold til det at studere. Ideen var nu at udvælge studerende med en udpræget overflade tilgang og sammenligne disse med studerende med en udpræget dyb tilgang til læring i forhold til deres udbytte af undervisningen i Arbejdsfysiologi 4, hvor undervisningen var planlagt så den skulle anspore til dyb læring.

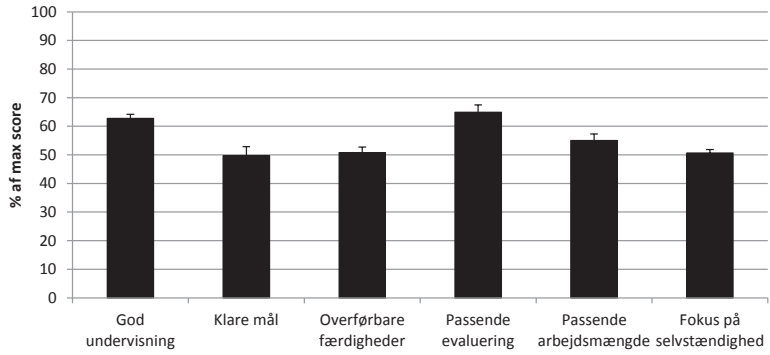
Evaluering af Arbejdsfysiologi 4

Evalueringen af Arbejdsfysiologi 4 fremgår af figur 2.4. Selvom den samlede evaluering ikke er interessant i forhold til de overordene spørgsmål, jeg ønsker at besvare i dette projekt, kan det give indikationer om, hvordan de studerende generelt har opfattet undervisningen. To parametre, det vil sige god undervisning og passende evaluering, skiller sig ud ved at ligge et stykke over gennemsnittet, mens de øvrige parametre bliver vurderet gennemsnitligt af de studerende.

Hvis man ser på hvilke udsagn, der trækker scoren inden for kategorien god undervisning op, er det udsagn som “Underviserne på det her kursus



Figur 2.3. Signifikante ($p<0,05$; n=38) korrelationer mellem (A) dyb og overfladedemotivation og (B) mellem dyb motivation og dyb strategi. Disse korrelationer danner basis for en udvælgelse af studerende med en udpræget dyb læringstilgang, som så kan sammenlignes med studerende, der i højere grad anvender en overfladetilgang til læring.

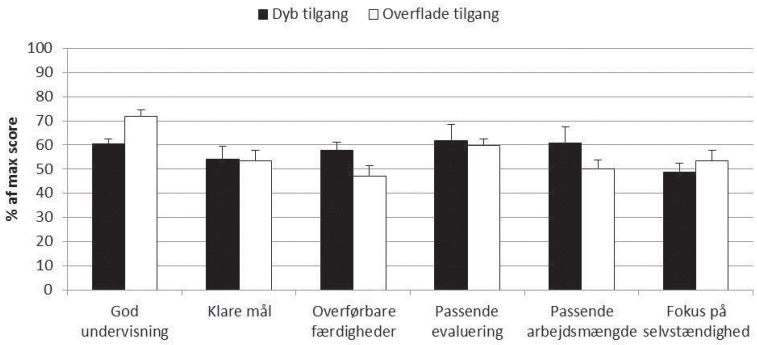


Figur 2.4. Overordnet evaluering af Arbejdsfysiologi 4 ud fra seks parametre baseret på et tidligere udviklet spørgeskema (Wilson et al. 1997). Generelt er de studerende tilfredse med undervisningen, og de føler at de bliver godt evalueret og får god feedback undervejs i kurset. De øvrige parametre bliver gennemsnitligt vurderet af de studerende.

motiverer de studerende til at gøre deres bedste" og "Vores undervisere er ekstremt gode til at forklare ting til os". Alle undervisere på dette kursus har undervist i flere år og har derfor sandsynligvis haft det overskud, der skal til for at motivere de studerende og forklare de vigtige ting grundigt. Det udsagn, der scorer lavest (ca. 42 % af max score) i denne kategori, er udsagnet: "Underviserne giver normalt hjælpsomme tilbagemeldinger om hvordan du klarer dig på kurset". Selvom underviserne sandsynligvis har haft overskud til at motivere og forklare, så savner de studerende åbenbart at få tilbagemeldinger om, hvordan de klarer sig i løbet af kurset. Dette står i kontrast til at kategorien passende evaluering faktisk ligger over gennemsnittet. Udsagn i denne kategori handler dog mere om evalueringsformen, der blev anvendt undervejs på kurset, end i hvor høj grad de studerendes indsats blev evalueret af underviserne. De studerende er for eksempel blevet bedt om at tage stilling til udsagn som: "Alt du behøver for at gøre det godt på det her kursus, er en god hukommelse" og "Det virker som om underviserne hellere vil teste hvor meget du husker, fremfor hvor meget du har forstået". Det er opløftende at netop denne kategori scorer højt, da det betyder at den måde kurset blev tilrettelagt på har fordret en dyb læringstilgang hos de studerende. På den måde er den høje score i denne kategori en validering af anvendeligheden af dette kursus til at besvare mit primære spørgsmål i dette projekt, nemlig hvilket udbytte studerende med forskellig tilgang til læring har af et kursus, der ansporer til dyb læring.

Som beskrevet i Metodeafsnittet udvalgte jeg de 12 studerende med den højeste og laveste "deep approach"-score og undersøgte deres svar fra evalueringsskemaet. Figur 2.5 giver en oversigt over resultatet. Der er tre forskelle, der er værd at lægge mærke til. Det er bemærkelsesværdigt at studerende med en overfladetilgang synes bedre om undervisningen end studerende med en dyb tilgang. Det kan skyldes at studerende, der tager en overfladetilgang, i højere grad har brug for undervisere, der er gode til at forklare pensum og gøre det spændende; og det har de fået på dette kursus.

En anden forskel, der er mellem de to typer studerende og deres udbytte af kurset, er i hvor høj grad kurset har udviklet deres generelle færdigheder i forhold til problemløsning: det at arbejde i en gruppe, deres analytiske færdigheder og strukturering og planlægningen af hjemmearbejdet. Her er det de studerende med den dybe tilgang, der synes at have fået mest ud af kurset. Det kan skyldes at de allerede besidder disse færdigheder på et højere niveau end studerende med en overfladetilgang, og at de således bliver bekræftet i deres måde at lære på. Omvendt er færdighederne hos studerende med en overfladetilgang måske mindre udviklet og de kunne have haft



Figur 2.5. Sammenligning mellem den evaluering studerende (n=6) med en dyb tilgang til læring har givet Arbejdsfysiologi 4 og den evaluering studerende (n=6) med en overfladetilgang til læring har givet kurset.

sværere ved at arbejde under de arbejdsformer, kurset anvendte. Studerende med en overfladetilgang har dog sandsynligvis det største potentiale til at forbedre færdighederne og de vil derfor med de rette undervisningsformer på sigt kunne blive bedre på disse områder. Den sidste iøjnefaldende forskel mellem de to grupper af studerende er deres vurdering af arbejdsbelastningen på kurset, og om kurset prøver at dække over for stort et pensum. At de studerende med den dybe tilgang i højere grad mener at arbejdsbelastningen er passende er måske fordi de netop via deres tilgang bedre evner at læse og forstå pensum end studerende med overfladetilgangen.

Konklusion og perspektivering

Dette projekt havde til formål at karakterisere studerende på Arbejdsfysiologi 4 og at undersøge, hvad to forskellige typer studerende får ud af et kursus, der var planlagt, så det kunne anspore til dyb læring. De studerende på dette kursus anlægger generelt en dyb tilgang til læring, men hvis man inden for denne gruppe ser på de studerende med den højeste og laveste score for den dybe tilgang og undersøger, hvordan de evaluerer Arbejdsfysiologi 4, så træder nogle forskelle frem, der kunne være en konsekvens af de færdigheder, de to grupper studerende besidder. Det vil være min

påstand at disse færdigheder kan læres og at det primært gøres i situationer, hvor der er fokus på at stimulere den indre motivation. Sidst men ikke mindst er det vigtigt at understrege at tilgangen til læring er kontekstspecifik. Således kan studerende, der tillægger en dyb tilgang i Arbejdsfysiologi 4, godt tillægge en overfladetilgang i andre fag og omvendt. Tilgangen til læring er således dynamisk og en forståelse for denne dynamik vil kunne bidrage til at optimere undervisningen og dermed de studerendes udbytte.

A Spørgsmål til underviserne på Arbejdsfysiologi 4

Jeg kunne godt tænke mig at få et overblik over hvordan I overordnet brugte de tre undervisningsgange. I bedes derfor besvare følgende spørgsmål for hver af de tre undervisningsgange.

1. Hvilke(n) undervisningsform(er) anvendte du (angiv ca. %):
    a. Forelæsning
    b. Tavleundervisning
    c. Gruppearbejde med efterfølgende opsamling
    d. Dialog-baseret undervisning
    e. Anden form (beskriv)

2. Hvad gjorde du for at aktivere de studerende undervejs?
    a. Jeg stillede spørgsmål som de studerende skulle reflektere over (hvor mange?)
    b. Jeg gav dem små opgaver som de skulle løse i par (hvor mange?).
    c. Jeg brugte Socrative en eller flere gange (hvor mange?)
    d. Jeg lavede andre ting (beskriv)

3. Opsatte du klare læringsmål for undervisningen, så de studerende var klar over hvad du forventede af dem?
    a. Ja
    b. Nej
    c. Jeg gjorde noget andet (beskriv)

4. Hvordan passede undervisningstiden i forhold til det pensum du havde planlagt at gennemgå?
    a. Det passede fint
    b. Jeg havde for meget med og nåede ikke at få alle mine pointer frem
    c. Jeg havde for lidt med

5. Hvor stor vægt lagde du på (angiv %):
    a. Arbejdsfysiologi relaterende emner
    b. Basal fysiologiske emner
    c. Ren biokemi

B Undersøgelse af motivation og tilgang til læring

Dette spørgeskema indeholder en række spørgsmål om din tilgang til dine studier og din normale måde at studere på. Der er ingen *rigtig* måde at studere. Det afhænger af hvad der passer din stil og din uddannelse. Det er derfor vigtigt at du svarer på spørgsmålene så ærligt som du kan. Hvis du mener at dine svar afhænger af det specifikke kursus på din uddannelse skal du tage udgangspunkt i det/de kurser der er de vigtigste for dig. Vælg en af svarmulighederne A-E ud for hvert spørgsmål. Bogstaverne angiver følgende:

A) Dette passer aldrig eller sjældent på mig
B) Dette passer sommetider på mig
C) Dette passer på mig ca. halvdelen af tiden
D) Dette passer ofte på mig
E) Dette passer altid eller stort set altid på mig

Vælg venligst det ene svar der passer bedst på dig. Brug ikke lang tid på at svare. Din første indskydelse er sandsynligvis det der passer på dig. Tænk ikke på at gøre en god figur; dine svar er helt anonyme.

1) Jeg oplever nogle gange at det at studere giver mig en følelse af dyb personlig tilfredsstillelse.
2) Jeg oplever at jeg er nødt til at arbejde så meget med et emne at jeg kan danne mine egne konklusioner før jeg er tilfreds.
3) Mit mål er at bestå kurset med så lille en arbejdsindsats som muligt.
4) Det eneste jeg læser grundigt er pensum.
5) Jeg føler at stort set ethvert emne kan være yderst interessant når jeg sætter mig ind i det.
6) Jeg oplever de fleste nye emner som interessante og bruger ofte ekstra tid på at sætte mig ind i dem.
7) Jeg synes ikke mine kurser er specielt interessante så jeg bruger kun et minimum af tid på dem.
8) Jeg lærer mange ting på remse og gentager dem om og om igen indtil jeg kan dem i søvne, også selvom jeg ikke forstår det.
9) Jeg oplever at det at studere akademiske emner kan ofte være ligeså spændende som en god bog eller film.
10) Jeg tester mig selv i de vigtigste områder af pensum indtil jeg forstår dem fuldstændigt.
11) Jeg oplever at jeg kan bestå de fleste eksamener ved at huske nøgleområder af pensum frem for at prøve at forstå dem.
12) Generelt læser jeg kun det der specifikt er angivet, da jeg mener at det er unødvendigt at gøre noget ekstra.
13) Jeg arbejdet hårdt på mine studier fordi jeg finder emnerne interessante.
14) Jeg bruger meget af min fritid på at finde ud af mere om interessante emner vi har diskuteret på forskellige kurser.
15) Jeg oplever ikke at det hjælper mig at studere emner i dybden. Det forvirrer og er spild af tid når alt jeg behøver, er at bestå kurserne.
16) Jeg mener ikke at underviserne skal forvente at de studerende bruger tid på emner alle ved ikke bliver brugt til eksamen.
17) Jeg kommer som regel til timerne med spørgsmål jeg gerne vil have svar på.
18) Jeg kigger som regel på det foreslåede læsestof der hører til de enkelte lektioner.
19) Jeg bruger ikke tid på læsestof, der sandsynligvis ikke bliver pensum til eksamen.
20) Jeg oplever at den bedste måde at bestå en eksamen på er at prøve at huske svarerne på de spørgsmål, der sandsynligvis kommer.

C Evaluering af Arbejdsfysiologi 4

Når du udfylder spørgeskemaet, vurder venligst kurset som en helhed fremfor at tænke på specifikke emner eller undervisere. Spørgsmålene er relateret til generelle spørgsmål om dit kursus, baseret på kommentarer som studerende ofte har nævnt i sammenhæng med deres oplevelse af undervisningen eller det at studere på universitetet. Emnerne giver point fra 1 til 5 på følgende måde:

1. Helt uenig; 2. Lidt uenig; 3. Hverken uenig eller enig; 4. Overvejende enig; 5. Helt enig

Vælg venligst det ene svar der passer bedst på dig. Brug ikke lang tid på at svare. Din første indskydelse er sandsynligvis det der passer på dig. Tænk ikke på at gøre en god figur; dine svar er helt anonyme.

1. Det er altid nemt at vide hvilken standard der er forventet af mit arbejde her.
2. Dette kursus har hjulpet mig at udvikle mine færdigheder til problemløsning.
3. Det er få muligheder for at vælge de særlige emner som jeg ønsker at studere.
4. Underviserne på det her kursus motiverer de studerende til at gøre deres bedste.
5. Arbejdsmængden er for stor.
6. Dette kursus har gjort mine analytiske færdigheder bedre.
7. Underviserne giver ofte udtryk for at de ingenting kan lære af de studerende.
8. Du har et godt billede af hvad du skal lave og hvad der forventes af dig.
9. Underviserne bruger meget tid på at kommentere de studerendes arbejde.
10. Alt du behøver for at gøre det godt på det her kursus, er en god hukommelse.
11. Dette kursus har hjulpet med at udvikle mine færdigheder i forhold til det at arbejde i en gruppe.
12. Dette kursus har gjort at jeg nu føler mig mere selvsikker i forhold til at håndtere ukendte problemer.
13. Dette kursus har forbedret mine skriftlige kommunikationsevner.
14. Det virker som om pensummet prøver at dække for mange emner.
15. Kurset har fået mig til at ville udvikle mine egne akademiske interesser så meget som muligt.
16. De studerende har mange muligheder for at vælge hvordan de vil lære i løbet af kurset.
17. Det virker som om underviserne hellere vil teste hvor meget du husker, fremfor hvor meget du har forstået.
18. Det er ofte svært at forstå hvad der forventes af dig i dette kursus.
19. Vi får generelt nok tid til at forstå de ting vi skal lære.
20. Underviserne gør meget for at forstå de vanskeligheder de studerende møder i undervisningen og deres studier.
21. De studerende her får meget frihed i forhold til at vælge den måde arbejdet skal laves på.
22. Underviserne giver normalt hjælpsomme tilbagemeldinger om hvordan du klarer dig på kurset.
23. Vore undervisere er ekstremt gode til at forklare ting til os.
24. Målene med dette kursus er ikke særlig tydelige.
25. Underviserne arbejder hårdt for at gøre emnerne interessante.
26. For mange af underviserne stiller kun 'fakta'-spørgsmål og ikke spørgsmål der tester forståelsen af emnet.
27. Som studerende her er der meget pres på dig.
28. Dette kursus har hjulpet mig med at udvikle mine færdigheder til at planlægge mit eget arbejde.
29. Tilbagemelding på de studerendes arbejde gives ofte kun i form af rettelser og karakterer.
30. Vi diskuterer ofte med vore undervisere eller tutorer hvordan vi skal lære pensum til dette kursus.
31. Underviserne viser ingen interesse i hvad de studerende har at sige.
32. Det ville være muligt at bestå dette kursus, kun ved at arbejde hårdt op til eksamen.
33. Dette kursus prøver virkelig at få det bedste ud af alle de deltagende studerende.
34. Der er meget lille variation i den måde man bliver vurderet på i dette kursus.
35. Underviserne gør det fra starten meget klart hvad de forventer af de studerende.
36. Størrelsen af pensum til dette kursus gør at man ikke kan forstå alt lige godt.
37. Samlet set er jeg tilfreds med kvaliteten af dette kursus.

3

Course development for laboratory exercises in Organic Chemistry and Spectroscopy to stimulate deep learning

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Introduction

The Organic Chemistry and Spectroscopy course at the (former) Faculty of Life Sciences, University of Copenhagen, for second- and third-year students provides general organic chemistry training for a variety of different educational programmes. The primary recipients are students from the biotechnology field. The teaching of the course is divided into (i) lectures, (ii) theoretical exercises, and (iii) laboratory exercises. Twenty-eight students attended the laboratory course. The laboratory exercises were conducted as group work in pairs, and two supervisors were allocated to the course. Thus, seven teams or 14 students were supervised by each supervisor. The practical part of the laboratory exercises was conducted over a period of five weeks with one course day of 4.5 hours each week. Subsequently, one week was allocated to reporting of results.

In general, students enrolled in the course have attended several chemistry courses prior to the Organic Chemistry and Spectroscopy course, and they have also completed laboratory exercise courses in an introductory chemistry course and in biochemistry courses. The students therefore have already acquired some basic technical laboratory skills and are accustomed to laboratory teaching.

A key focus of the course, as a whole, is to motivate students to learn the basic concepts underlying chemical reactivity.

Identification of problem and focus area

The course has been taught for several years with remarkably good evaluation of the theoretical aspects from students in mandatory course evaluations. The laboratory exercises, however, have suffered from very poor evaluations in the preceding years, and course development within this part of the course is clearly required.

A general problem of this type of laboratory course that is taught concurrently with lectures is that the exercise content is often ahead of the lecture content. A widespread consequence of this fact is that the treatment of the theoretical background of the exercises is postponed until the final part of the course and the student report writing phase, and students are left with little or no supervision of the learning process. Additionally, supervisors obtain a low level of feedback on the student learning progress.

The focus of this project has been to elevate the treatment of theoretical and conceptual aspects of the exercises into the earlier parts of the laboratory course, and to allow students to have feedback on their learning progress along the course. Three pedagogical measures to stimulate deep learning (Biggs & Tang 2007) were evaluated in the current project: (i) The application of an open and flexible course structure (evaluation of current course structure), (ii) individual team discussion sessions, and (iii) a formative course reflection or evaluation process.

Several other important problems could be identified, however, these are not elaborated in the current project.

Methods: Description of pedagogical measures

Motivating students: Open and flexible course structure

An important aspect of student motivation is the opportunity for students to take ownership in the teaching and learning activities (Biggs & Tang 2007). The laboratory exercises constitute a great opportunity for students to participate actively in decision making regarding the subject, planning and conduct of experiments, and reporting of results. The course previously had a relatively open and flexible structure; students in teams would be (i) allowed to pick four exercises of their own choice from the laboratory manual, (ii) schedule the five course days individually to complete their four exercises, and (iii) decide how to report their results. This part of the

course was considered to be aligned well with the intention of motivating the students.

On the first day of the laboratory course a plenary introduction was given with the aim of matching expectations between students and supervisor in terms of (i) the active participation required of the students, and (ii) that the primary focus of the course was not on the final, summative assessment of student reports.

Team discussion sessions

The decision to maintain an open and flexible structure of the laboratory course obviously had some consequences for the potential of conducting plenary introductions and instructions to individual exercises. On the other hand, the high degree of supervising time available for each student in this part of the course allowed for dedicated, individual team supervision. A scheme for conducting these discussion sessions was developed through the course period: Individual teams would prepare for topics of their own choice and sit down with the supervisor to discuss the difficulties most often related to the theoretical and conceptual background of the exercises. Typically, one discussion session was conducted with each team for each course day.

Formative course reflection and evaluation process

A formative evaluation process, consisting of written questionnaires and plenary discussions of student responses for each course day, was conducted. A summary of the questions is listed in Appendix A. Topics such as Intended Learning Outcomes (ILOs) of the course, student peer supervision, student preparation and course improvements were discussed. The purpose of this process was to make students reflect on various aspects of the teaching and learning process through the course in order to stimulate the students to abandon a surface approach and adopt a deep approach towards learning.

Evaluation of teaching methods from the student perspective – Focus group interview

A focus group interview was conducted at the end of the course in order to evaluate the teaching methods from the student perspective. Five students

from three different teams participated in a joint interview over a period of 1.5 hours. The interview guide is listed in Appendix B. The following section contains a summary of the interview responses with a focus on factors related to motivation and teaching methods.

The students reported that they were positively surprised by the open structure of the laboratory course. From previous introductory laboratory courses they were expecting a rigid structure with fixed exercises for individual course days and plenary introductions to exercises. One student explained how the fixed structure in one course had led students to perceive the conduct of the exercises as a racing game with the goal of finishing their exercises before the other students. The open structure relieved this type of inter-team competition, and also led to a more thorough conduct of the exercises due to the inability of students to compare exercise results with neighbouring teams. None of the interviewed students found that the freedom to select exercises or the consequences thereof had led to frustration or confusion and in their opinion that was not the general feeling among other students either. On the other hand, students pointed to a lack of clear framing of the course as a main element of confusion; (i) the laboratory course was not adequately introduced during the lectures, (ii) there was some confusion as to the number of practical course days, (iii) the deadline for handing in reports was given too late, (iv) the duration of individual exercises was unclear, (v) technical support from lab technicians was inadequate, etc. Relatively simple adjustments within these areas would mean that a lot of confusion could be avoided.

A second main element of confusion was the style of the laboratory manual. All the students interviewed found the manual confusing and difficult to apply for the planning of the experiments, which was an important part of motivating the students (vide supra). An overview of workload for all exercises and a clearer designation of workload for different course days within each exercise again would avoid a lot of confusion with relatively simple means. A discussion of the technical language of the manual as a motivating factor resulted in conflicting views from the students; some students thought that technical terms should be complemented with thorough textual explanations in the manual whereas other students reflected on the potential loss of motivation or ownership from a highly detailed manual. However, none of the interviewed students were interested in a downgrading the technical language leading to a cookbook-style manual.

The students were highly satisfied with the team discussion sessions, and they stated that this part of the laboratory course had a strong influence

on their performance in the final course exam within the areas of writing reaction mechanisms and spectroscopic interpretation, which are two central ILOs of the course. Importantly, the consultative style of the sessions was stimulating for the students. The students reported that they were not accustomed to engaging in the theoretical background of the exercises before or during the conduct of the exercises from previous laboratory courses. In previous courses with written questionnaires before exercises (so-called pre-lab), students said there was a high degree of copying of responses between students and a low personal benefit; however, with the open course structure and individual selection of exercises this could less problematic. Students were hesitant to agree that an understanding of the theoretical and conceptual background prior to or during the conduct of an exercise was necessary to motivate them, however, they agreed that background knowledge enhanced their motivation. Some students said they only realized the true value of the team discussion sessions at a later stage.

The students reported that they were unfamiliar with the course reflection or evaluation process and that they found great difficulties in answering the questionnaires. Some students said they found the process irritating or annoying.

Evaluation of teaching methods – Personal reflections

Student motivation

Students were generally highly motivated towards performing the laboratory exercises according to the laboratory manual instructions and towards finalizing exercises. They were to a high extent self-driven and able to work independently with the exercises. On the first course day we discussed during a reflection and evaluation session, the potential for student peer supervision to promote student reflection and deep learning (Biggs & Tang 2007, Hofstein & Lunetta 2003); the individual scheduling of the exercises allowed in some cases for one team, who had completed a given exercise, to supervise a second team on the conduct of this exercise. It was my impression that the students benefitted from peer supervision. The students in the focus group interview also responded positively to peer supervision and said they had benefitted personally.

Even though we had spent some time explaining that the focus of the course was not on finalizing exercises this was clearly an important concern

of the students during the course. The individual scheduling of the course days meant that many teams would initiate several exercises concurrently which resulted in a poor level of day-to-day understanding of individual exercises and a further drive towards finalizing exercises. These activities may be explained as a negative backwash effect (Biggs & Tang 2007), i.e. students focus on the assessment task, in this case the delivery of the required reports to the supervisor at the end of the course and on gaining answers to questions posed in these reports (Krystyniak & Heikkinen 2007).

It was my impression that student reactions towards the open and flexible course structure fell into two groupings; some students responded positively and were motivated by the possibilities for independent course participation, however, other students found the lack of structure confusing. As such, the course structure might demotivate some students. This could perhaps in part be explained by differences in student attitudes towards learning as described by Perry (Winberg & Berg 2007).

Team discussion session

The laboratory course is taught concurrently with lectures. Previously, an early treatment of the theoretical background of the individual exercises in the laboratory course has generally not been encouraged, and theoretical aspects have been deferred to the student reporting process at the end of the course. This approach may be more or less informally communicated. Students are to a great extent accustomed to this way of teaching from previous introductory laboratory courses. In the extreme cases, the practical part of the course becomes completely detached from the theoretical part, and students follow the laboratory manual blindly with little idea about what they are actually doing in the laboratory and why. I would argue that this teaching approach encourages students to adopt a surface approach to learning (Biggs & Tang 2007). This view is also supported by students in the focus group interview. Additionally, there is empirical evidence indicating that most students will not learn the theoretical concepts that underlie the exercises in passing from conducting hands-on activities, rather, explicit instructional efforts should be devoted to conceptual learning (Tamir 1989).

At the outset of the course, discussion sessions with individual teams were conducted on an ad hoc basis. Students would fill out a questionnaire at the beginning of each course day to point out which topics or problems they would like to discuss, and we would sit down for 10-20 minutes when time permitted. Initially it was difficult for students to allocate the time

for these discussion sessions, and I had to persuade some teams to devote the time. Additionally, some students were poorly prepared for the discussion. This problem was discussed with my pedagogical supervisor Lotte E. Sjøstedt; as an outcome, a fixed timetable (scheme) was instigated for the discussions. The timetable had several positive consequences: (i) I did not have to spend time gathering students, (ii) students were better prepared since they knew when the session would begin, (iii) time was spent more efficiently during the discussions, which could be shortened to 10 minutes per team. Students also responded positively towards the fixed timetable in the focus group interview.

When students participated in the discussion sessions it was my clear impression that they found the sessions highly stimulating and rewarding. The consultative style of the sessions motivated students to bring up problems of all kinds that they had encountered. The working atmosphere was positive and students were not afraid to take part and make mistakes. Perhaps most importantly, the discussions allowed me to assess the students individually and stimulate the learning process by questioning students at their individual level. This format thus allows teaching that builds upon and enhances students' knowledge, attitude and perceptions described as a special opportunity for laboratory courses by Hofstein & Lunetta (2003). Both declarative and functioning knowledge (Biggs & Tang 2007) could be assessed and stimulated in these sessions.

A few topics that were general to all exercises, mainly regarding spectroscopy and reporting of results, were introduced in plenary discussion sessions. Students were reluctant to participate in open dialogue to discuss their own difficulties in interpreting results. This behavior was in sharp contrast to the open attitude during the individual discussion sessions. In plenary sessions, only one or two students participated actively whereas all students participated actively in discussion sessions.

Formative course reflection and evaluation process

The main purpose of this process was to make students abandon a surface approach by raising their awareness of teaching and learning aspects particular to the laboratory exercise format. Additionally, the process was intended to explicate the general and specific purposes of laboratory activities, and explicate course objectives to reduce a negative backwash effect (vide supra), as the explicit format is an important guide for the teaching and learning process (Hofstein & Lunetta 2003).

The written format of the questionnaires prompted students to take part in the reflection and evaluation process, although the level of detail in responses was low. An effort was made to phrase questions in colloquial language in order not to startle students. A discussion of the course ILOs was conducted on the first course day with good student response, however, student response in plenary discussions was again generally low.

The extent of the reflection and evaluation process was lowered on the third course day after some criticism that the discussions were taking up too much time. At this point, however, the intended main objectives of this process were achieved.

Conclusions

Three pedagogical measures to stimulate deep learning were evaluated in the current project:

Firstly, the open and flexible course structure adopted was found to motivate students, as intended. Students responded positively and said it led them to take ownership in the teaching and learning activities. There was some discrepancy between my own observations and student responses in the focus group interview at this point; it seemed to me that the freedom to select exercises was a source of confusion to some students, however, students reported that confusion resulted from the poor framing of the laboratory course and from the laboratory manual. These findings should be utilized in the further development of the laboratory course.

Secondly, the team discussion sessions allowed the treatment of theoretical aspects of the exercises in the earlier parts of the laboratory course. Students found these sessions highly stimulating and rewarding. The discussions allowed me to assess the students individually and stimulate the learning process by questioning students at their individual level. Importantly, students reported that these sessions had a strong influence on their learning outcome and performance at the final exam.

Thirdly, the formative course reflection and evaluation process fulfilled the purpose of explicating learning outcomes and raising students awareness towards teaching and learning aspects. However, students were reluctant to participate and criticized the process.

In summary, these results indicate that a deep learning approach could be stimulated, and that this should be an integral part of future course development.

A Summary of questions from formative course reflection and evaluation questionnaires (translated)

Course day	Question
1	Try to describe what you think are the objectives of this laboratory course?
1	How do you think the dialogue with the supervisor has been today?
1	What did you think worked well about today's exercise?
1-5	What could be improved for the next course day? Where should the focus be? (recurring)
2	How much time did you spend preparing for today's exercise? (a) 0 min, (b) 15-30 min, (c) 30-60 min, (d) 60-120 min, (e) >120 min
2	How well prepared for conducting today's exercise did you feel? (a) poorly, (b) not so good, (c) so, so, (d) well, (e) really well
2	To what extent did you feel that you understood the theoretical background and procedure of the exercise before the conduct of the exercise? (a) poorly, (b) not so good, (c) so, so, (d) well, (e) really well
2	How did you think the individual walk-through of the exercise with the supervisor proceeded?
3	What do you expect to learn today?
3-5	What would you like to talk about for the individual team discussion session today? (recurring)
4	How did you benefit from the plenary discussion on spectroscopy?
5	Which elements of the spectroscopy assignment did you find challenging?
5	Did the team finish the practical part of all exercises? What remains?

B Focus group interview guide (translated)

Overall evaluation

- How do you evaluate the laboratory course overall?
- How do you evaluate the interplay between the laboratory course and the lectures?
- Did the laboratory course fulfill your expectations? Which expectations did you have?

Evaluation of elements of the laboratory course

- The freedom to select exercises and planning of course days was intended to motivate students and allow students to take ownership in the teaching and learning activities. Did that make you feel motivated? (pros and cons)
- In your opinion how are students motivated for this type of laboratory course?
- Peer supervision. What did you think about that? (as supervisor/pupil)
- Do you feel that it is important to understand the theoretical background of the individual exercise before/during the conduct of the exercise? Is it OK to postpone this to the writing of the student reports at the end of the course?
- Do you think it is a good idea to keep the technical language style of the laboratory manual?
- Team discussion sessions – How was your personal benefit? How could it be improved?
- How do you evaluate the influence of the laboratory course (specifically the team discussion sessions) on your overall learning outcome within the areas (i) reaction mechanisms, (ii) NMR spectroscopy?
- Pedagogical questionnaires and discussions – How did they work out? (pros and cons)

Future course development

- Please describe some positive experiences from previous laboratory courses?
- The laboratory manual was evaluated negatively at the course evaluation. How do you think a better manual could be created? As a “cook-book”?
- Would you prefer more ”open” or more ”closed” types of exercises?
- Would it be a good idea to instigate questionnaires before the conduct of exercises (pre-lab)?
- Other suggestions for course improvements?

4

Use of formative assessment to improve student motivation and preparation for exams

Susanne Pors

Department of Veterinary Disease Biology, SUND, University of Copenhagen

Introduction

I am one of the teachers on the course "Speciel patologi og fjerkræsygdomme" (Special Pathology and Poultry Diseases) which was held for the first time in 2011/12. The course is taught in the third year of the veterinary degree programme and is mandatory for all veterinary students. The course replaced, after a restructuring of the overall plan for the veterinary curriculum, a previous course which was placed on the master's degree level. At the same time, the course was reduced from two weeks to one week of practical training, and the final evaluation of the students changed from an oral examination to a practical written examination. However, the structure of the course – including learning objectives, teaching and learning activities and curriculum – remained the same. In the new format of the course the percentage of students failing the final exam increased from approximately 4 % to 20 %.

When evaluating the answers from the practical written exam it is clear that the students were not well prepared for the theoretical contents and form of the final exam. There could be several reasons for this including: the structure of the course (theoretical and practical teaching are separated by up to several months), the placing of the course in the veterinary curriculum (bachelor versus master students), and the motivation of the students to participate in the course (poultry is not the most appreciated animal species among veterinary students).

These are all matters that are worth considering as possible areas of improvement, but these are also issues that are dealt with on a higher adminis-

trative level. Therefore, in this project I have chosen to focus on a didactic method that can be used within the existing format by evaluating the use of formative assessment to improve: students' motivation for learning and their understanding of the contents, level and form of the final exam, and as a method for the students to be aware of their own skills within the course.

Method

Students attending the practical part of the course in May 2012 were given a quiz with ten questions covering some of the topics included in the course curriculum. The questions were designed to have broad answers and in a form that could be used in the final practical written exam. After 45 minutes of work with the questions, either individually or in groups, all questions were answered in plenum with input from the students on each question and final validation by myself. In addition, all students were requested to answer a questionnaire before the quiz and after the plenary session. The questions regarded the students' perception of their motivation, their work during the course and their possibilities to pass the exam.

Result

The sample of students who participated in the quiz and answered the questionnaire consisted of four males and twenty-two females, all veterinary students participating in the course for the first time. All students had participated in the teaching more than 80 % of the time. Furthermore, only two students answered that their motivation for participation in the course was below average, while the remaining stated that their motivation was average (n=20) or above average (n=4).

The number of answered questions were seven or above (Fig. 4.1A) and only one student answered only one question. The numbers of answers corrected after the plenary session (Fig. 4.1B) were fairly evenly spread from one to ten questions. However, the degree of correction was not referred in the questionnaire, which could be a useful parameter for the students' knowledge of the topics.

Before the quiz, three students were not motivated for learning and no students had the highest score for motivation. After the quiz, the motivation moved up on the scale, showing that the quiz and plenary session brought

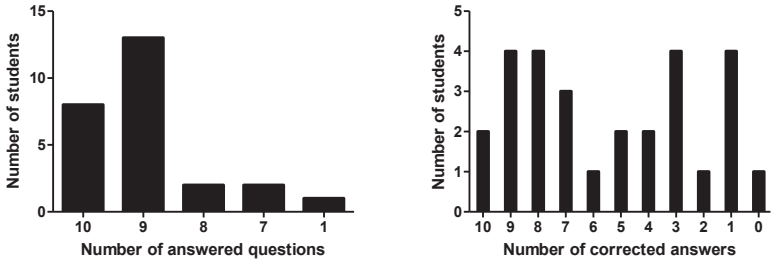

Fig. 4.1. A: Number of quiz questions answered. B: Number of answers corrected during the plenary session.

an increase in motivation for learning (Fig. 4.2). The students' perceptions of their understanding of the contents of the course before and after the course remained unchanged by the quiz (Fig. 4.2).

A slight change was found in the students' perception of passing the exam in both positive and negative direction, as both an increase in score 4 (Good chance of passing exam) and score 1 (Some chance of passing exam), together with a fall in score 2 (Fair chance of passing exam) was found.

Score*	Motivation for learning		Perception of understanding of course		Perception of possibilities of passing exam	
	Before	After	Before	After	Before	After
1	3	0	0	0	0	0
2	11	8	3	3	6	8
3	12	14	19	18	18	14
4	0	4	4	5	2	4

*: Score: 1: None, 2: Some, 3: Fair, 4: Good

Fig. 4.2. Motivation for studying, perception of understanding of course and perception of possibilities of passing exam before and after quiz and plenary session among 26 veterinary students.

All students participating in the formative assessment session passed the course at the following exam.

Discussion and perspectives

Formative assessment is a teaching and learning activity that can give students information on their progression in learning the course and help to improve their next performance (Askham 1997, Biggs & Tang 2007). The feedback given by formative assessment gives the students an opportunity to reflect and improve their learning (Gibbs & Simpson 2004, Biggs & Tang 2007).

Through a quiz consisting of ten questions, the students participating in this present KNUD-project gained a higher motivation for learning. Furthermore, students can increase their awareness about their own likelihood of passing the exam and thereby this helped them to prioritize their work in preparation for the final exam. The number of questions answered was high and, even though many answers were corrected after the plenary session, this indicates that the students participated willingly in the exercise. Furthermore, the final (summative) exam will be a more familiar and known format through practising during the course by using this form of formative assessment.

Using formative assessment during the course gives me as a teacher the opportunity to adjust the planned teaching. Almost all the students misunderstood or did not answer two of the ten questions, and thereby this have us an indication that these topics need more attention in lectures. Furthermore, this can be a method to bring the theoretical aspects of the course closer to the practical parts. The two parts of the course are now separated by an interval of one to five months. Bringing more theoretical questions in to a practical setting will help the students to focus on both parts of the course, also those topics not used during the practical hands-on part of the course.

In conclusion the present project shows, that formative assessment is easily implemented in the course “Speciel patologi og fjerkræsygdomme” in the existing format of the course and can lead to an increased motivation for studying and learning in the students.

Part II

Evaluating and revising existing courses or units – course development

5

Challenges in planning a course with multiple teachers and independent experimental projects

Henning Osholm Sørensen

Department of Chemistry, SCIENCE, University of Copenhagen

Introduction

For the past two years I have been giving a lecture on powder X-ray and neutron diffraction as part of a course titled "Structural Tools in Nanoscience". The course is taught by several teachers each an expert in a particular experimental technique. The intended learning outcome (see the full course description in Appendix A) is that the students shall became familiar with a number of experimental techniques used to characterize materials with structures on the nanometre scale and be able to choose techniques suitable to characterize samples of their own choice. I became interested in analyzing the challenges of running a course with many different teachers and which puts a lot of responsibility on the students to form the experimental part of the course. This report will consist of my thoughts and initiatives to modify the latest (block 4, 2012) course based on student evaluations from 2010 and 2011 as well as my own experience with the course. I became involved in the course quite late and since I am not formally responsible I have not had the capacity to change the course description or the exam form. In this report I will discuss the ideas for improving the course and the factors limiting the practical implementation.

The challenges are to ensure that teachers of the course provide coherent teaching, which inspires the students and gives them sufficient background for performing an experimental project independently. Apart from the challenge to make a coherent schedule for the lectures it is also challenging to plan the experimental part in relation to the lectures as it is up

to the students to decide which experimental techniques they will use and when.

Methods

The ideas for the initiatives to modify this year's course were obtained from an analysis of the standard evaluation forms filled out by students taking the course in 2010 or 2011, from one semi-structured interview with a student from 2011 and from discussions with other teachers on the course. The ideas for improvements of the course were partly implemented in the 2012 course. Finally, evaluation schemes made from students following the 2012 course and semi-structured interviews with three students served to evaluate the course structure of 2012.

The questions of the semi-structured interviews, shown in Appendix B, were grouped into questions concerning the lectures, the experimental work, coherence between lectures and experiments, and study material. Furthermore, the 2012 students were also asked questions about student participation. Audio files of the interviews can be obtained upon request (henning.osholm@gmail.com).

Results

Analysis of the course years 2010-11

The standard evaluation schemes used by the university administration to evaluate the course served as the first source of information of what students felt about the course. The analysis is based on seven students taking the 2010 course and three students taking the 2011 course. In the following I have tried to extract general conclusions from the students' individual responses.

Lectures

The key importance of lectures in this course is: (1) to introduce the students to a pamphlet of experimental techniques, (2) to make the students aware of the benefits and pitfalls, (3) thereby to enable the students to make

educated decisions on their project, and (4) to motivate the students by having dedicated teachers giving examples of the possibilities of the technique, hopefully with exciting examples from their own research.

One of the special features of this course is that the lectures are performed by several different teachers. The basic idea is that experts within the different techniques are best at presenting the techniques and not least are engaged within their field of expertise which hopefully shows in the teaching situation. This feature also seemed to be appreciated by the students:

> "Underviserne er engagerede og venlige" (The teachers are engaged and friendly) (Student, 2010).

The more negative remarks are related to lack of coherence between the teaching of the different teachers:

> "Many different teachers – basics are repeated quite often" (Student, 2010).

A similar remark was made in an interview, where it was mentioned that lectures were presented well but they lacked continuity. This is unsurprising as it takes a lot of collaboration between the teachers to align their lectures such that they do not repeat each other – especially because some of the techniques are based on the same underlying physical principles. On the other hand, repetition can also serve the students to give them a sense of knowing the subject and thereby be more motivated to follow the lecture. Motivation is of course a prime factor for students to get deeply involved in the course and its material. It is up to the teacher to motivate the students, this is best done by involving them in the teaching, instead of giving the classic one-way lecture. This quality might have been lacking in some of the lectures.

> "The lectures were sometimes a bit boring. Some of the lecturers should engage the students in discussion, in order to make the class a bit more interesting" (Student, 2010).

Experimental work

A very important part of the course is the experimental work. The students should independently, in groups of three or four, find a sample which they find interesting, and decide which of the techniques presented in the course

they can use to characterize the sample. The students find that the experimental part is very important and in that way they learn to compare techniques. Furthermore, the course enables them to judge what kind of experiments to perform in order to get insight into their material. But a common comment was that they feel that they are not involved enough in the experiments. On the question: Did you feel involved in the experimental work? The answer was:

> "Not quite, there is a tendency that the experiments are rushed (maybe in 1 to 2 hours) and mostly performed by the supervisor. Maybe because we only have to use the instrument once during the course. Lacking hands on experience." (Interview with student, 2011).

Similar remarks were made by other students.

Intended initiatives for 2012

From the analysis of the evaluation of earlier courses it is clear that the four-block structure of the teaching year is challenging for a course with the present ILOs: the students have to learn about a number of potentially new techniques, the physics behind them, the benefits and limitations of the techniques, before being able to make an educated decision on which techniques they intend to use on their samples. Since there is only about eight weeks for the course it is not, in the current state, possible to get through all the techniques before the students have to decide, which techniques they intend to use and make arrangements to use the relevant instruments.

In a planning meeting which most of the teachers attended I presented my ideas, based on the evaluations of earlier courses and the interview, for revisions to the course. We discussed the ideas and how to implement them. In the following I will present the initiatives taken.

It was decided to structure the list of lectures such that the techniques most likely to be chosen by the students were taught first etc. Though this may sound simple, it was a difficult task to accomplish because many of the teachers were engaged in other activities during the course period. Another initiative was to minimize the overlap between lectures. This also meant that additional constraints were put on the order of the lectures. To minimize the overlap, two new sets of lectures were introduced: (X-ray) Scattering and Crystallography were made separate themes as they are an important part of several techniques.

In the lectures we wanted to engage the students more and make the lectures more closely related to the experimental part of the course. It was also suggested that teachers should be more aware of pedagogical principles like introducing the ILOs for the lecture before starting, and conducting teaching-learning activities (TLAs). Suggestions for each of the particular techniques are specified below:

Atomic Force Microscopy (AFM): Introduction of a new TLA – doing a AFM experiment and exercise on paper, and including a tour of the instrument (half toured the instrument while the other half did the assignment, and vice versa).

Scanning Electron Microscope (SEM): The SEM talk was moved to an early stage of the course and an instrument visit was included.

Small Angle X-ray Scattering (SAXS): A practical computer exercise was added to complement the theoretical part.

Scattering techniques and Crystallography: The Scattering lectures were also to be taught differently – it was to be performed in dialogue with the students with small buzzing exercises. In the Crystallography lecture more TLAs were introduced.

Powder diffraction: buzzing exercises and tour of the instrument were introduced. One of my ideas for more student involvement was for a discussion of a scientific paper to be part of the presentation of the techniques. The paper was given to students in advance, and they were expected to read it before the lecture.

Experimental part

Some initiatives were conducted relating to the experimental work. The first was to postpone the group formation until after the first three sets of lectures to avoid students forming groups with those whom they knew beforehand rather than with those having a different background but with whom they might have a common interest in particular samples.

The students had also pointed out that they feel there is a lack of hands-on experience in the experimental work. It was therefore suggested that there should be more focus on making the students involved in the experiments.

Discussion

??? It is easy to wish and envisage how the ideal course should be. Unfortunately, in reality there are many constraints and obstacles. Constraints are issues like the structure laid out for the teaching. At the University of Copenhagen, Faculty of Science this means a nine-week teaching period of which the last week is often used by the students to prepare for exams. This structure puts a lot of pressure on a course like the one analyzed here. It would be optimal if the students had been introduced to all the techniques before they have to perform the experimental part of the course. Until recently I have found that to be difficult. For the past years there have been two double lectures per week (subtracting all the weeks with holidays). To get through all the techniques the lectures were spread more or less over the full eight weeks. In 2012 the structure was generally retained. In order to ensure that the students could start early in the course period to chose techniques for their project which they knew about, the order of the lectures series was designed such that the techniques with the highest possibility of being chosen for the experimental work were covered first. Unfortunately there was an obstacle to this plan – coordinating the teaching schedule with the schedules of the teachers. An additional constraint was that the basic lectures (Scattering and Crystallography) should be given before the lectures on techniques based on these. Those constraints meant that some techniques normally used by many of the groups ended up rather late in the course. This was far from ideal. Two students interviewed after the 2012 course suggested that all the lectures could be presented in the first part of the teaching period. The benefits of doing that would be (1) the techniques could all be taught before the experimental work, (2) because the lectures are concluded before the experimental work, students can avoid making arrangements to conduct experiments during lectures (3) because of points (1) and (2) and the fact that class attendance is normally higher in the early part of the course, the general attendance would probably rise.

> "Stort set alle kurser er ikke så intense i starten, men er meget intense til sidst." (Almost all courses are not that intense in the beginning but very intense at the end.) (Interview with students, 2012)

The downside is that the lecture programme would be very compact and the time for students to prepare would be less.

How to include the basic physical principles

One of the initiatives was to minimize the repetition of the basic physical principles in the lectures. This has historically happened as many principles are common to several techniques. In practice this was solved by introducing separate lectures on the common basic principles. It seemed to work well as no one mentioned problems with overlapping lectures until I specifically asked for remaining overlaps. One student mentioned that a little bit of repetition was still present. The example given was that in electron microscopy two different techniques are presented and the principles behind the generation of electrons etc, which is common to both, are taught in detail twice. One interesting comment made in the interview with the students was that they prefer lectures to focus on the applications and the research rather than the physical principles because, as they put it: "the physics we can always look up by ourselves". One challenge in this respect is that the backgrounds of the students attending the course are quite diverse, e.g. this year students from physics, nanotechnology, chemistry and earth science attended.

More TLAs in the lectures

One focal point this year was to introduce more TLAs to get the students more motivated and involved in the theoretical part. In the SAXS lecture a computer exercise was introduced. The students should learn how to analyze data and determine object shapes and sizes from the data. In this way the students learned how to analyse one type of SAXS data, but they also learned of possible pitfalls in the data analysis. Furthermore, possible misinterpretation was discussed. Despite this, in my opinion, rather positive outcome of the exercise, there were critical remarks by some students. The criticism targeted that the exercise was based on determining the shapes of proteins in solutions. They felt that this was too far from their own research interest in nanoscience, partly because specialized software was used. I believe that the students learn a lot from this type of TLA, but to really engage the student the case needs to be closer to an application suited for the type of materials to be studied in this course.

Experimental part

The experimental part of the course is expected to be carried out independently in groups. The students have their own projects, for which they are

responsible: they decide the techniques to use for gaining the information they need and they make arrangements with researchers to help them perform the measurements. Therefore the projects mimic a real research situation. Hence this is a very good example of what problem-based learning should achieve (Biggs & Tang 2007, p. 154). The independence of the groups to design and perform the project also creates a challenge for the course planning. You never know ahead of time which group will choose which technique. One year everyone might decide to use one particular technique, another year no one will use it. But it is exactly the independence of the groups to define their project and decide which experimental techniques to use that makes the present course so distinctive. This aspect of the course is also clearly what makes it popular amongst the students. The challenges of the planning also make the project very realistic and make them aware of the difficulties of performing a general research project.

> "Learning practical research. This is something that makes this course worthwhile. The insight in applying knowledge to real problems." (Student, 2011)

The negative remarks of former students about how groups formed early in the course often led to groups of people with similar background and gender, was considered for the 2012 course. The group formation was postponed a couple of weeks in order for the students to become more familiar with each other and to have time to discuss ideas about projects. This initiative was partially successful – groups were formed of students with diverse backgrounds, but the gender separation still remained.

Another issue raised by former students was the lack of hands-on experience during the experiments. Before the 2012 course the teachers discussed this aspect and we agreed to aim at involving the students more in the practical work wherever possible. According to the student interviews we did not succeed in achieving this goal. One of the reasons for the limited direct participation of the students in the actual measurements is that the students generally only use each technique (the one they choose) once, therefore it is more time consuming if the students themselves should perform all the experimental steps. The time aspect in this respect is important because the instruments are the work horses of the research groups and are often paid for by grant money. This means that the instruments are used quite heavily and at the same time several student groups might want to use the equipment. Again the short block structure of the course limits the time which can be used for these measurements. Apart from the time constraint,

the limitation of hands-on experience is that the instruments are complex and fragile, and inexperienced operators might harm them. This could mean that the research groups will have difficulties fulfilling their obligations to the funding agencies. That said, we still have to make a better plan for how we can improve the involvement of the students in the experiments. Part of this could be through improved course material. Presently the course material is limited to electronic reproductions of books or articles as well as PowerPoint slides[1]. Without too much effort we might prepare some specific documentation for each technique, covering the basic operations of the instruments, which would enable the students to have a better basis for taking part in the experiment. Alternatively we could improve the communication and make them aware that they are the managers of the project, and therefore they need to know the techniques, but they are not expected to perform the experiments, rather they will be guiding the experiment in collaboration with a skilled technician.

Conclusions

It is clear that challenges still remain in planning a course of the present type with many teachers and a high degree of independent experimental work. The analysis of former courses and experience with adjustments made to this year's course showed that improvements can be made to increase the coherence between lectures but also more adjustments could and should be performed. The TLAs introduced this year were generally successful, but from the student evaluation is was also clear that the TLAs should be closely aligned with the real experiments in order to be meaningful for them. Planning a course of this type is limited by a number of constraints, e.g. the busy schedules of the teachers. Another limitation is that many teachers are not on a university salary, but funded by grants etc., thereby limiting the time they can spend on the course. The same reasons limit the time that can be spent on the experiments. So even with the best of intentions and ideas of how the course could be planned and what teaching material should be available, we are unfortunately limited by resources. If I were responsible for the course next year, I would try the model of running all the lectures in the first three or four weeks and dedicate the last four

[1] In the semi-structured interview there were also questions regarding the course material. In order to keep the focus of this report an analysis of the course material has been omitted from this paper.

weeks to the experimental work. Furthermore I would put more emphasis on making TLAs with clear relevance to the experimental part.

A Information on the course

Information from SIS on the course Structural Tools in Nano Science

Udgave:	Forår 2012 NAT
Point:	7,5
Blokstruktur:	4. blok
Skemagruppe:	A
Uddannelsesdel:	Kandidat niveau
Kontaktpersoner:	Robert Feidenhans'l (robert@fys.ku.dk)
Andre undervisere:	Erik Johnson (johnson@fys.ku.dk) Susan Stipp (stipp@geol.ku.dk) Tue Hassenkam (tue@nano.ku.dk)
Skema-oplysninger:	Vis skema for kurset Samlet oversigt over tid og sted for alle kurser inden for Lektionsplan for Det Naturvidenskabelige Fakultet Forår 2012 NAT
Undervisnings-periode:	23. april til 15. juni 2012. Eksamen i perioden fra d. 18. – 22. juni 2012
Undervisnings-form:	lectures and exercises in groups.
Formål:	The purpose of the course is to give an introduction to modern charactisation tools in surface and nano science. The tools include STM, AFM, electron microscopy, x-ray scattering based techniques plus a range of chemical analysis tools like X-ray photo-electron spectroscopy. The students will work in groups of about four people and choose their own set of samples which they will characterise with a subset of the techniques presented in the lectures. The students will learn about the applicabities of the techniques and learn how to use them in practise.
Indhold:	In the course we will discuss some of the most important experimental tools for advanced structural characterisation in nano science.The tools could include: (i) scattering methods based on x-rays and neutrons (small angle scattering, reflectometry, EXAFS, diffraction) (ii) Scanning and transmission electron microscopy (iii) Scanning probe methods including STM and AFM (iv) chemical characterisation tools (XPS, contact angle, TOF-SIMS). The course will give a thorough understanding of the physical basis of the techniques and of their strength and weaknesses. Local experts from other

institutions and companies will be invited to give highlight examples and excursions will be arranged for demonstrations. A large part of the course is experimental, where the students will use the techniques on their own samples and learn about their applicability the hard way. The course is evaluated by a written report and a poster session.

The course will also include an excursion to a company or institution, which uses advanced characterisation tools in nano science.

Målbeskrivelse:

The goal of the course is to give the student knowledge about modern characterisations tools in surface and nano science. The student should know the basics of a range of techniques that will enable him/her to evaluate what kind of structural information a given technique can provide and what not. This could be information about atomic or crystalline structure, mesoscopic structure or chemical structure. The student will also be able to judge the applicability of the techniques concerning the form of the sample, whether it is single crystal, powder, flat or rough.

The student will be able to use the techniques in practice. The experimental part is very much student driven. The student be able to organise the lab work working in a team, keeping a logbook, arrange laboratory time and seeking information about the interpretation of results, etc.

Finally, the student must be able present the result in a written report and also to present it as a poster.

Lærebøger: Noter uddelt ved forelæsningerne.

Tilmelding: Via Selvbetjeningen

Faglige forudsætninger: Bachelor indenfor en naturvidenskabelig retning.

Eksamensform: Passed/failed, internal censorship. Written report + an oral poster presentation. One report and one poster is made pr group.
Participation in the experimental activities and contribution to a written rapport and a poster are required before the students can participate in the examination.
Re-exam: Oral examination.

Eksamen: Mundtlig prøve den 21. juni 2012.
Reeksamen: Mundtlig prøve den 23. august 2012.

Undervisnings-sprog: Engelsk

B Questions asked in the semi-structured course

Questions asked in the semi-structured interviews.

Teaching type and coherence between presentations of the techniques?

- What is your thoughts on the way the techniques were presented?
- Was the physics behind the techniques teached at the right level?
- How would you suggest the teaching was organized:
    - Is it better to have all the physics behind each technique presented with it?
    - Or is better to collect the physics in one lecture (set of lectures) and then refer to that in the presentation of the individual applications with a short reminder?
    - Was there too much overlap between lectures?

Coherence between presentations and experimental work

- Did you feel that the lectures gave you the background for performing the experiments?
- Were there too many techniques (sub-techniques) presented compared to what was actually possible to perform experiments with?

How did you find the experimental work?

- Was there enough time allocated for the experimental work?
- Did you feel involved in the experimental work?

Study material

- Was the expected study material available?
- What is your opinion on the material?
- At one lecture (at least) a paper was distributed to the students for preparation and was supposed to spawn a discussion about the benefits and possibilities of a method. Do think such an initiative is useful?

Student participation

The participation for the lectures were generally low (∼50% in average)

- What was your participation?
- What was the reason for your amount of participation?
    - Do know whether other participants had similar reasons?
- What would it take to increase your level of participation?

Expectations and outcome

- Did the course cover the expected subjects/methods

- Do you think the learning objectives laid out for the course was met?

6

Going deeper than common sense – revision of the exam in the course Public Health and Nutrition based on peer teacher discussions and constructive alignment theory

Camilla T. Damsgaard

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Introduction

As a teacher and examiner on the master's degree course "Public Health and Nutrition" in 2010, I found that the format and content of the final oral exam made it difficult to test students' knowledge and their ability to apply it adequately. The curricular exam questions appeared to me superficial and easy, and did not allow us to assess deep learning, despite the fact that the intended learning outcomes (ILOs) for the course (Appendix A) included competences at the highest levels of the SOLO taxonomy (Biggs & Tang 2007). In spring 2012, I was one of the persons responsible for the course and it gave me a chance to try and improve the exam.

Aim

The aim of this project was to revise and evaluate the oral exam in Public Health and Nutrition in order to:

- Improve the alignment of the exam with the predefined ILOs
- Put more focus on assessing deep, functioning learning, not just declarative, surface-oriented learning.

The course Public Health and Nutrition

Public Health and Nutrition is a compulsory 7.5 ECTS course at the master's degree education in Human Nutrition at the Faculty of Life Sciences, University of Copenhagen. It is conducted in Danish and consists of theoretical lectures and guest lectures where current public health interventions are presented. A major activity is a group assignment in which the students have to design an intervention to solve a public health challenge, using the planning model Logical Framework Approach (LFA). The course also includes a stakeholder document which the groups have to revise and update regarding the role of stakeholders in the field. This document is part of the exam curriculum. The final summative student evaluation is a twenty-minute oral, individual exam with no materials permitted. It consists of a five-minute presentation by the student of their LFA report, five minutes discussion of the report, and five plus five minutes exam on two short curricular questions, without time for preparation. Due to university regulations, we were not allowed to change this overall four-part examination format.

Approach

Ideas from Professional Learning Communities and Constructive Alignment

Since I was one of four persons responsible for the course, I decided to use structured peer group discussions with my colleagues as a means of planning, implementing and evaluating revisions to the final exam. This type of teacher team work in order to improve students' learning borrows elements from the professional learning communities (PLC) described by Stoll et al. (2006) and used in some public Danish schools. The key elements and strengths of PLCs are to build among the teachers (and others involved) shared strengths and visions, a collective responsibility, a reflective dialogue about teaching practices, collaboration, and to improve learning, not only among the students, but also among the teachers (Stoll et al. 2006). Building a PLC would be far too elaborate for the scope of the present project. Rather, I borrowed elements from this way of thinking and tried to incorporate it in the way we worked with the course.

I decided to focus on the part of the exam concerning questions from the general curriculum, not the LFA part. An important aspect of constructive

alignment is to make sure not only that the exam reflects the ILOs, but also that these are aligned with the teaching and learning activities used in the course (Biggs & Tang 2007). Although some adjustments were made to the teaching and learning activities of the course, the main focus of this project will be on the curricular part of the final exam.

Empirical method

Based on my previous reflections and last year's course evaluation, I made an outline for the semi-structured peer group discussions (Appendix B). Three key areas were considered: Format and coverage, deep versus surface learning, and alignment. I participated in the discussions, took notes and tape-recorded it all, to make sure I did not miss anything. Based on the key points of the first discussion, I made suggestions for exam revisions that I presented in overview and discussed with my peers.

My final versions of the curricular exam questions were tested during the June 2012 exam. Finally, the new exam structure and usefulness of the revised exam questions were evaluated in the third discussion session with my peers (Fig. 6.1). I also developed a simple questionnaire for the students to fill out immediately after the exam but before they received their grade (Appendix C). This was based on five-point Likert scales (Likert 1932) and had open fields for qualitative comments.

Box 1: Empirical matter for this project

- Last years' student course evaluation
- Semi-structured peer group discussions of exam questions
  - Before course start (discussion 1)
  - During the exam planning phase (discussion 2)
  - After the exam (discussion 3)
- Short anonymous exam evaluation questionnaire filled out by the students after the exam (before grading)

Fig. 6.1. Empirical matter for the project.

Findings and reflections

Evaluation of previous year's course

The course teachers stated that the previous year, the exam questions should have been better prepared, i.e. the examiner should check beforehand whether all aspects of the questions were indeed covered by the curriculum. A figure or picture used in the teaching could be shown in order to support the students. Some of the questions should be posed more specifically and we should try to write the questions during the teaching of the subject. The previous year's grade points were rather high; 55 % of the students achieved 10 or 12 and no one failed the course. The teachers stated that since half of the exam was based on the discussion of the students' own LFA report, it was hard to fail. When I raised this issue with my peers, we decided to assign only three minutes for the students' presentation of their LFA reports, and give us, as the examiners, more time to ask in-depth questions about the report. Here we would ask for critical views and draw in theoretical models.

Discussion session 1 and 2 – Teachers' identification of problems and potential solutions

I started the first discussion session by showing the current ILOs of the course and of the whole master's degree in Human Nutrition. To our surprise, the majority of the intended competences of our candidates were based on learning from our course. In order to evaluate the alignment of the course, we went through each of the previous year's exam questions and discussed which of the course ILOs (Appendix A) they referred to. Overall, the exam questions were aligned with the course ILOs, but mainly at the lower taxonomic levels. However, the ILOs were rather broad and could be interpreted in different ways. As recommended by Grønbæk & Winsløw (2003), we decided that I should present and explain our interpretation of the ILOs on the first day of the course, to make the students aware of the demands of and competences given by the course.

A number of very ambitious key points appeared from the first discussion:

- Ideally, the exam questions should have both a specific part and a broader part.

- Some important aspects of the taught areas, which were not previously covered by the exam, should now be included (e.g. ethnic minorities and screening).
- Some exam questions were irrelevant or could be answered from common sense and were therefore removed (e.g. listing of UN organisations).

Most existing exam questions should be revised in order to:

- Be more specific (e.g. refer to specific points from a curricular article)
- Be more elaborate (e.g. include sub-questions) and clear
- Be more challenging (e.g. ask students to apply concepts to unfamiliar examples given in the question)
- Be more theoretically founded, and/or
- Demand answers at a higher taxonomic level i.e. include a more critical angle or analytical and discussing approach, not only the listing of things (Biggs & Tang 2007), and
- The questions should be posed in a way that corresponded to the way the material was taught in our adjusted course, e.g. by use of more examples, cases etc.

The revised exam questions were discussed in the second peer discussion, and were, after further changes, reviewed by two of my peers. The final versions of the curricular questions were tested during the oral exam in June 2012. I added figures to two of the questions, but found it unsuited to the rest of the questions. I supplied the exam questions with short answers in note format and with suggestions for extra questions that the examiners could ask within that theme, if time allowed. These were typically questions that invited discussion or comparison of concepts. Examples of old and revised exam questions are given in Appendix D.

Did it work?

Students' evaluation of the exam questions (quantitative and qualitative)

All students who took the exam filled out the evaluation questionnaire shown in Appendix C (n=48). In addition to their quantitative answers, most students wrote helpful qualitative comments in the open fields of the questionnaire.

In response to the statement "The exam question reflected the intended learning outcomes for the course" the median response among those who drew each of the questions were either strongly agree, partly agree or somewhere in between. The overall distribution of answers to this statement (Fig. 6.2) shows that very few students found that one of their questions were outside the scope of the course ILOs.

"The exam question reflected the intended learning outcomes for the course"		**"The exam question reflected the way we have been taught the topic"**	
Answer	**%**	**Answer**	**%**
Strongly Agree	54	Strongly Agree	43
Partly agree	36	Partly agree	42
Neither agree or disagree	6	Neither agree or disagree	6
Partly disagree	3	Partly disagree	7
Strongly disagree	0	Strongly disagree	2

All student s (n=48) drew two questions each (total N=96).

Fig. 6.2. Students' answers after the oral exam.

Although a few more students disagreed that the exam question reflected the way they had been taught about the topic, 85 % agreed either strongly or partly (Fig. 6.2). However, when evaluating the answers for each exam question separately, I identified two questions (number 10 and 11) which seemed to get the lowest average scores on alignment (Fig. 6.2). These were case-based questions about stakeholders. According to the open field comments, the students were quite happy with these case-based exam questions, but they criticized that no cases, student exercises or discussions had been used in the teaching of the stakeholder document. As one student wrote: "Just writing about the stakeholders does not give the discussions I need for the exam". When I presented this to my peers we decided to make a bigger effort next year to revise that part of the course, by use of cases, questions, exercises and a reduced curriculum in order to improve learning.

The qualitative part of the questionnaires also showed that the exam questions were much more specific than the students had expected. Specificity was actually one of the goals of my exam revisions. However, I think we could improve the way we prepare the students for the exam, since as summarized by Gibbs & Simpson (2004), clear goals and standards are

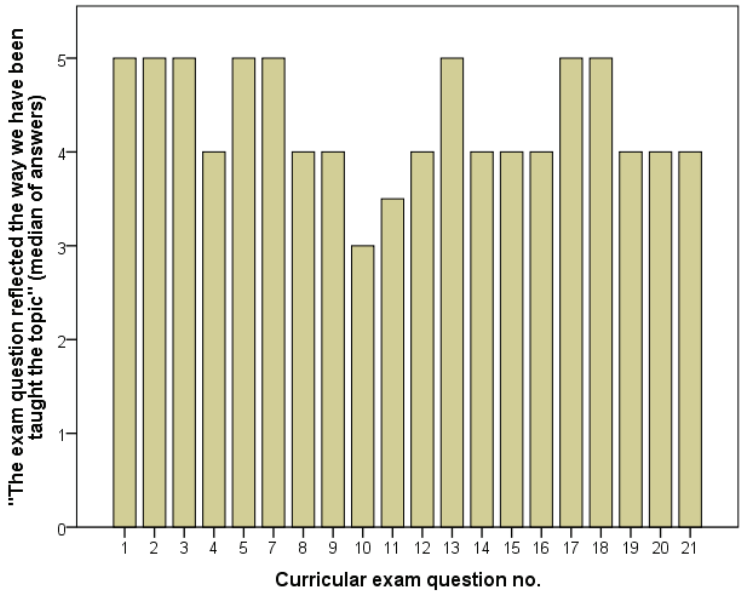

Fig. 6.3. Median of students' answers to whether the exam and teaching was aligned, for each of the exam questions. 5=Strongly agree, 4=Partly agree, 3=Neither agree or disagree, 2=Partly disagree, 1=Strongly disagree. The 21 exam questions were drawn between two and eight times each.

important for quality learning. As planned, I presented and explained the course ILOs to the students at the start and end of the course. Next year, I will try to be even more specific, give examples and ask how they interpret the ILOs – maybe make a mock exam for them with peer student feedback and assessment. We also agreed that next year we will put more emphasis on key concepts that we think are important for the students to study in detail and incorporate exercises in these concepts for them to practise their skills. I hope that this will create a positive back-wash effect (Biggs & Tang 2007) i.e. encouraging appropriate and ILO-oriented learning. Finally, some students noted that the exam questions were clear and easy to understand. I think this is very important.

Discussion session 3 – Teachers' evaluation of the new exam questions

At the final peer discussion session, I showed figure 6.3 and some of the students' qualitative answers to my peers. This led to some very fruitful discussions about which particular teaching sessions should be improved and how. The main conclusions from the exam week and the final peer discussion were that the revised exam questions were well-structured and more aimed at testing the students' abilities at different (and higher) taxonomic levels than previous years' questions. Also, the extra questions (for the examiners only) were very helpful and all relevant parts of the curriculum were covered – and all but one question were covered by the curriculum. The extra time allowed for discussion of the LFA group report (now seven minutes versus five minutes the year before) worked well. However, we also identified a number of things that we would change in next year's questions, after trying them in practice. It was difficult for my peers to assess (and remember) whether this year's exam made it easier to distinguish the academic level of the students compared with the last year. This year's median grade point was quite high (7.9) but only 39 % of the students received the grade 10 or higher, as compared to more than 50 % last year. As last year, I think this is partly due to the fact that half of the grade is still based on their discussion of their LFA report. However, I also think this indicates that the design-oriented LFA group report is something from which the students gain a lot.

Other observations and reflections

It struck me that, despite our focus on the ILOs, we examiners did not always agree on what a good answer was. Although most students could give a theoretical definition of the concepts, they differed in their ability to apply, exemplify and use them. I think that no matter how well you design your exam questions, your ability to discriminate a candidate's academic level depends on your own definition of knowledge and your questioning technique. Another problem I find hard to overcome is that none of us found time to read the full curriculum before the exam. This is to me a structural issue that has to do with the way teaching is weighed against research and production of articles in the university system.

Conclusions and perspectives

By use of peer teacher discussions and student evaluations, I have identified some key points for improvement of the oral exam in our course, in order to improve assessment of deep learning and constructive alignment. The revision and testing of the exam showed overall a high degree of satisfaction from the point of view of the students and indicated that the exam questions had improved in terms of structure and assessment of learning at different taxonomic levels. However, the student evaluations and peer discussions also showed that parts of the course could benefit from further revisions in order to improve alignment and student learning and clarify the expectations for the exam.

Personally, I found peer teacher discussions a highly useful way of evaluating and improving course planning, while at the same time creating ownership, engagement and new common insight among the teachers. This is in line with the strengths of PLCs described by Stoll et al. (2006). Also, I was positively surprised by the enthusiasm my peers put into the process – despite its demanding and time-consuming nature.

A Intended Learning Outcomes for "Public Health and Nutrition 2012"

(Translated from Danish.)

After the course the students should be able to:

Knowledge

- Describe basic concepts and strategies in public health science, with special focus on nutrition and health.
- Describe the processes behind the planning of public health interventions in the field of nutrition
- Identify central public and private stakeholders within nutrition and demonstrate overview of their responsibilities in Denmark

Skills

- Apply theories on the planning of preventive strategies and interventions and demonstrate the ability to conduct a needs analysis, define goals, identify determinants for the behavior of the target group, choose relevant methods and evaluate the intervention.
- Compare and evaluate nutrition and food policies, nationally and internationally

Competences

- Discuss interests related to the production of policies of relevance to nutrition in the Danish population
- Critically evaluate central concepts and existing interventions in the health area
- Plan a health-promoting intervention by use of an acknowledged planning model, e.g. the Logical Framework Approach.

B Peer discussion guide

Format and coverage

- Does the exam have the relevant format (within the regulations) or what could be improved?

- Are all the relevant areas and concepts taught during the course covered by the exam?
- What is missing and what do we need to cover?
- How should these potential new questions be asked?

Deep learning vs. surface learning

- Are the curricular exam questions testing the students' ability to define, describe, list, identify and the like? (uni- and multistructural understanding in SOLO) or rather to apply, analyse, characterize, compare, create, design and invent? (relational or extended abstract)
- Should this be changed?
- Are the curricular exam questions relevant for the things we want the students to be able to do after taking the course?

Alignment

- Are the curricular exam questions aligned with the intended learning outcomes (ILOs)?
- Which are and which are not?
- Do the exam questions reflect the content and the form of the teaching during the course?
- What improvements could be made in order to make the exam questions reflect the ILOs?
- Should any improvements be made in the content and format of the teaching in order to improve alignment?

C Student questionnaire

A. My <u>first</u> exam question had number _____

1. The exam question reflected the intended learning outcomes for the course (**put one X**)
   ___Strongly Agree
   ___Partly agree
   ___Neither agree or disagree
   ___Partly disagree
   ___Strongly disagree

2. The exam question reflected the way we have been taught the topic (**put one X**)
   ___Strongly Agree
   ___Partly agree
   ___Neither agree or disagree
   ___Partly disagree
   ___Strongly disagree

Please comment:

B. My <u>second</u> exam question had number _____

1. The exam question reflected the learning objectives for the course (**put one X**)
   ___Strongly Agree
   ___Partly agree
   ___Neither agree or disagree
   ___Partly disagree
   ___Strongly disagree

2. The exam question reflected the way we have been taught the topic (**put one X**)
   ___Strongly Agree
   ___Partly agree
   ___Neither agree or disagree
   ___Partly disagree
   ___Strongly disagree

Please comment:

D Examples of old and revised exam questions

Translated from Danish

Example 1: Public Health Diseases

Old Question:
Give examples of the most important risk factors for public health diseases in Denmark

Revised question:
Public Health Diseases

- What characterizes a public health disease?
- Discuss why prevention of public health diseases is a national responsibility

Example 2: Stakeholders

Old Question:
Name the most important UN organizations who are involved in nutrition

Revised question:
Hip fracture and stakeholders.

A mentally healthy and well-functional 70-year-old woman falls in her home and is hospitalized with a broken hip. Analyse who has the economic responsibility for

A . . . her hospitalization
B . . . her recreation after discharge
C What other stakeholders would it be relevant for the woman to contact after her discharge from hospital?

Example 3: Ethnic minorities

There was no old question in this theme.

Revised question:
Ethnic minorities, diet and health

A What are the most common diet related health problems among fugitives and immigrants in Denmark?
B Discuss problems in relation to giving advice to parents of ethnic minority about their childrens' diets

7

Reflection on Pharmacokinetic tutorials – a qualitative analysis of students' expectations and evaluations

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Important points

Important points on tutorials at university

- Expectations should be aligned for optimal teaching.
- Time should not be spent on repeating basic knowledge; in this case, semilogarithmic graphs. Instead these could be provided to students and more time spent on interpretation and deeper learning.
- Peer-teaching could be a way to increase students' activity and responsibility.

Introduction

In university classrooms, lectures are the traditional form of teaching, meaning that the teacher gives a lecture and the students listen to the presentation. Tutorials can be taught as regular lectures as well, where the teachers go through the assignments at the blackboard.

However, in itself this is not adequate for creating good learning processes (Postholm 2011) and other methods have been suggested as well (Rump n.d.). For example, it has been suggested that the students can work in groups, finding and solving problems, and the blackboard can be used in between, when specific problems or issues are raised.

I had the task of teaching three different tutorial classes (A, B and C) in the same pharmacokinetic course. In my preparation, I talked to the person responsible for the course, to learn how these tutorials usually run. I was told that students would do calculations in groups. At the end of the sessions, results are given on the blackboard by the teacher, as there is not enough time to ask the students to present the results for the rest of the class. I was told that the students often find it very difficult to do these exercises and calculations.

However, after teaching the first class (A), I was very surprised at how unprepared the students were. This caused some problems in my teaching, as I had to explain very basic things before we could proceed. I could hardly find time to help them all, it ended up being quite chaotic, and some of the students left the class long before it ended.

My aim was to make a critical reflection on pharmacokinetic tutorials and thereby suggest issues for changes and improvement.

Method

After teaching my pharmacokinetic tutorial class at the School of Pharmacy, University of Copenhagen, I had the time to re-prepare for the next two lessons. My peers attended the first lesson, for peer-supervision, and I had a follow-up meeting with them after the tutorial. Moreover, I had the chance to discuss issues with my pedagogical supervisor before teaching the next two lessons.

I realized that I would like to know what the students thought they gained from my teaching, so I wrote them an email via the course homepage, Absalon, and asked them to evaluate my teaching in a few words. However, I had no responses at all for a month. Some weeks later a female student wrote back and answered few of my questions.

I thus learnt that Absalon was not the way to gain knowledge on students' expectations and evaluations as they never replied. Therefore, I decided to construct a questionnaire to hand out before teaching began for the next two classes. Also to prepare the students in the other classes, I wrote them all an email via Absalon and explained what I expected them to do in preparation for our next pharmacokinetic class. They only had to read the email and were not required to reply.

Moreover, in my planning I decided to implement a few changes in the teaching. In order to evaluate the teaching, and to support my own ob-

servations, I constructed a questionnaire to gain knowledge on students' expectations and evaluation. From the collected data, I planned to make a critical reflection. Therefore, I used the method illustrated in figure 7.1.

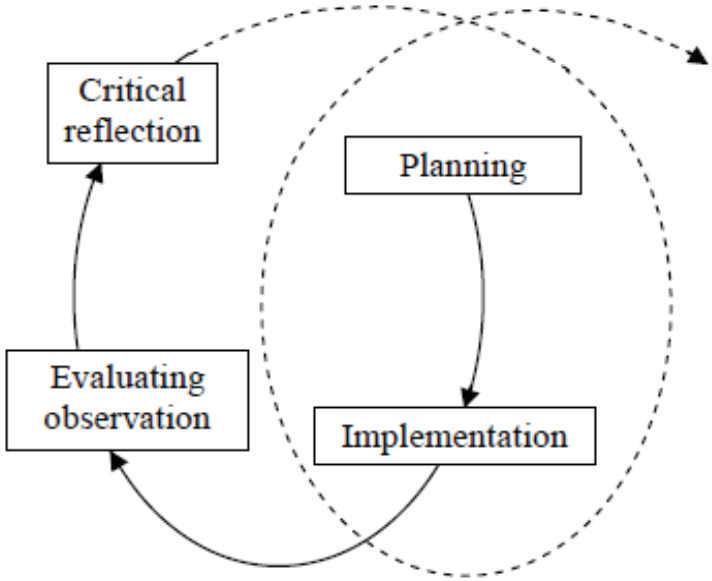

Fig. 7.1. Interaction between planning, implementation, evaluating observation and critical reflection. Thoughts on own teaching may lead to actions that are tested, but which upon critical observation is assessed as either to be discarded or improved. This means that an interaction is created between planning, implementation, evaluating observation and critical reflection, which is not only a circular process, but also a spiraling one moving in one direction finally to end in a focus or solution (Postholm 2011).

Planning

- After discussion with my pedagogical supervisor, I realized that I could use peer-teaching as a tool to activate those who already finished the assignments, and hereby to have better time to explain to those who found it really difficult.
- After discussing with my peers I decided to explain in details how the semilogarithmic plot should be made as I saw in the first lesson that this presented a lot of problems for the students, even though this is expected to be basic knowledge.
- I decided to hand out the graphs for the students so they could see what they should look like.
- I constructed a questionnaire to gain knowledge of students' expectations and their evaluation.

Implementation

I started the classes by introducing myself and my expectations as written in my email to the students via Absalon. I asked the students how many of them had read my e-mail before the class and how well prepared they were. I told them about peer-teaching and that both the student tutor and the tutee would benefit from it. I explained the semilogarithmic graph for the students and after the lesson I handed out the examples of the graphs.

After the lessons nineteen questionnaires were collected from one class (B) and twenty questionnaires collected from another class (C). The students were asked to fill in the first part of the questionnaire before we started the tutorial and to fill in the final part after the tutorial.

Results

In class B eleven of nineteen (58 %) and in class C six out of twenty (30 %) had read the email I sent out before the class.

Expectations

Two students in class B and five students in class C expected that the teacher would go through all exercises and demonstrate them on the blackboard.

Two students from class B and six students from class C would like to achieve skills which are necessary to pass the exam. Many (class B=9, class C=7) stated that they wished to achieve a better understanding of pharmacokinetics.

Students' preparation

Nine students from class B and twelve from class C did not do any exercises beforehand and very few managed to complete all the exercises on their own beforehand. Many students prepared for these classes by looking through the textbook, at slides from the general lecture or the assignments (class B=15, class C=13). One student pointed out that he or she did not prepare for class, as it was stated on the assignment sheet that the exercises would be done in the class.

Ten out of nineteen in class B and twelve out of twenty in class C would have prepared better for these tutorials, if they were to do it again.

Students' expectations

In class B ten students stated that their expectations were met. Three would have liked the teacher to have gone through the assignments at the blackboard. One student regretted that he or she was too unprepared for these tutorials.

In class C, fourteen students stated that their expectations were met. However, four of them also stated that there was too little time for the assignments and that it was too chaotic. One student was dissatisfied with the way of teaching and stated that, due to the fact that only a few students were prepared, it would have been better if the teacher went through all the assignments at the blackboard.

Student-reported outcome

All students reported positive outcomes such as better understanding of pharmacokinetics especially regarding one- and two-compartment kinetics and the difference between them.

Peer-teaching

This was not a theme in the questionnaire, these results are from my own observation. In class B, I specifically asked one student to help another and it seemed to go well. When I asked the former after the tutorials how he thought it went, he said that it is difficult to help someone who had not even read the book, but he tried his best. For explanation of assignment 2, I invited a student to the blackboard to explain the solution; it went well.

In class C, it was slightly more difficult to get the students to help each other. They had many questions and I was too busy to be able to encourage more peer-teaching.

Discussion – Evaluating observation

Other methods to provide understanding of teaching have been described (Postholm 2011). However, I found that the questionnaire was useful for the qualitative student evaluation and in combination with observations, I obtained a broad impression.

Aligned expectations?

I had to reconsider my teaching after my expectations of students' level of preparation were unmet. It is important that the tutorials are based on how well prepared the students are. However, after informing the students beforehand of my expectations, I still found a mismatch in expectations. Thus, I learnt that it is highly important to align expectations before the tutorials. This could be done in the general lectures, and the text on the assignment sheet should be rephrased to clarify expectations.

Basic knowledge and student preparations

How much time should a university teacher spend on repeating basic knowledge for the students? This is not an easy question to answer. Teaching the students how to draw the correct graph on a semi logarithmic plot met some problems and many minutes were spent on teaching this. These classes are not meant for such instruction, and it led to me having too little time to teach the actual exercises. Therefore, I would very much prefer ir if the plots were pre-drafted and given in the exercise. I am aware that drawing

these plots is included in these classes because it is part of the exam. However, I do not think that the students gain anything from drawing these plots. The point is that they should be able to interpret them. Therefore, I would suggest that the plots are provided both in classes and at the exam. This will give time for the things which are more important, including the exam situation, where time can easily be wasted in constructing these plots.

On the other hand, it should be possible to increase students' preparation for these tutorials. It could be stated on the assignment sheet, which skills are expected for these tutorials and perhaps some chapters could be recommended as reading beforehand. I got the impression that most of the students did not read anything in the textbook after the general lectures.

Peer-teaching

Both student tutor and tutee will benefit academically from peer-teaching, the tutor more than the tutee. Teaching a subject deepens students' understanding of it (Biggs & Tang 2007). However, even though I tried, I did not manage to optimize peer-teaching. I should have emphasized the importance and purpose of peer-teaching both before and during the classroom teaching. I could emphasize this on the blackboard by writing, for example, "Before you ask me, ask your peer or check your textbook".

Culture

The students are students in a number of different classrooms or activity systems. Therefore, they will experience several different ways of learning. Students from the Danish School of Pharmacy may be used to a culture where the teacher presents and talks, even when small classes are being taught. This may explain why some students preferred this teaching method. Another reason could be that if a student is less well prepared he or she is more likely to want the traditional form of teaching where the teacher presents all the solutions.

In both classes, I met opposition to the old fashioned logarithmic paper. I tried to explain the necessity for it. However, I did not have a really good argument, except that they had to be able to draw it in the exam as well. None of these students will ever again have to draw these graphs by hand. Therefore, I think it could be time to remove this task from tutorials and the exam. I think these graphs could easily be handed out to the students. The essential competence is that they are able to interpret the graphs, but I

think these skills can be obtained during tutorials without drawing graphs by hand. There would thus be more time for the actual assignment, as too much time was spent on drawing graphs.

Dealing with questions from students

Questions from students sometimes interrupted the classes, this was also reported by a few students. By increasing peer-teaching, I would have had more time for more important questions. Even though I tried to implement peer-teaching, it did not work out very well, as I still had a lot of questions to answer among the students. I have realized that I should have been better at appointing a peer student to raise the question to, or I should have told the students to try to ask a peer before raising their hands. On the other hand, it seemed as if they doubted the help a peer could give, and that they would prefer the teacher's answer. This may be due to the fact that they are not that much used to peer-teaching.

I would like to provide written solutions for the students immediately after the tutorials as they seemed eager to proceed at home to finish the exercises straight after the tutorial. However, I had the feeling that only a few of the students would be able to proceed without detailed solutions being provided. Therefore, I think it would be beneficial for the students to get solutions after each tutorial and not only when all the tutorials have been held, because at that time the eagerness to continue may have decreased. This was also reported by the students, who felt that more detailed solutions than those given on the blackboard were needed.

Conclusion

This assessment led to reflections on several issues. The most important ones are: (1) Expectations should be aligned for optimal teaching; (2) time should not be spent on repeating basic knowledge as semi logarithmic graphs, instead these could be provided and time could be spend on interpretation and deeper learning; (3) peer-teaching could be a way to increase students' activity and responsibility.

8

Stimulating student activity outside the lecture

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Introduction

Student activity forms the basis for student learning, and a wide range of methods have been developed and evaluated for stimulating student activity during lectures and exercise classes (Biggs & Tang 2007, Mazur 1997, Oikkonen 2009, Splittorf 2009) as well as activation tools for e-learning and interactive social media tools such as forums or chat rooms (Biggs & Tang 2007, Ch. 7). However, it is just as important to stimulate student activity outside the classroom, as this is where most of the students' time is spent. This is perhaps especially important in mathematics oriented courses, where it is necessary for most students to work actively and independently with the course content in order to learn it.

The aim of this project was to develop and test strategies for increasing student activity outside the lecture hall in the course "Data Analysis" taught in spring 2012 at the Department of Computer Science at the University of Copenhagen. Since lecture and exercise time is rather limited in a typical computer science course, most of a successful learning process must necessarily take place elsewhere. An important component in optimizing student learning is thus to stimulate students to work and prepare themselves outside the lecture.

Two different strategies were planned and implemented:

A) Case-based teaching, intended to encourage the students to prepare for lectures, and

B) Carefully planned case-based weekly assignments (constituting the exam) optimized to create a need to engage in course content and material.

The effect of the strategies was measured using two questionnaires at the beginning and middle of the course, a focus group interview at the end of the course and the general course evaluations, also at the end of the course.

Strategy A did not have the desired effect on stimulation of student activity and preparation for lectures, but the students reported that they liked this form of teaching very much; it made the course more interesting and meaningful, and made the theory more accessible.

Strategy B, however, proved to be very effective in stimulating student activity and the exercises were well received among those students who completed the course. A number of students dropped out of the course at the second home assignment, most likely because of the work load. A future challenge is thus to keep the success of the exercises in stimulating students to work while making the exercises accessible to a larger group of students.

Description of the course

Data Analysis is a course primarily intended for third-year Computer Science students. For many of the students, this is the last course in their bachelor degree. The intention of the course is to teach basic data analysis techniques and spur interest in data analysis by engaging the students in exciting problems and applications. The learning objectives included understanding and implementation of specific data analysis methods; choice of method; and analysis of methods used and results obtained. The exam consisted of graded weekly assignments, which were case-based exercises that typically involved analysis of a real problem, choice of method, implementation of the method and analysis of the results, taking into account the strengths and weaknesses of the method. Student collaboration was encouraged, but reporting was individual.

In addition to the official learning objectives, I had a personal agenda, which was also aligned with an unofficial purpose of the course: The students should have fun while learning. The weekly exercises were designed to give room both for a simple, standard solution but also for a deeper analysis and solution of the problem, intended to engage interested students.

Implementation

The two strategies were implemented as follows:

A) Each lecture ended with the presentation of a practical case, related to the theme of the following lecture, accompanied by reading material. The following lecture started with the same case, followed by an invitation to discuss the case. Throughout the lecture, the case returned as an example and at the end a final answer would be discussed, based on the lecture.
B) The weekly assignments all consisted of a practical case problem, sometimes accompanied by purely theoretical questions. Part of the problem was always an analysis of the choice of method and a discussion of possible improvements to the method. The effect of the assignments was continuously monitored through dialogue with the students, teaching assistants and the course responsible, as well as through questionnaires.

The effect of the two strategies was measured through the following means:

- Two five-minute questionnaires were completed; one during the first lecture and one after the second weekly assignment was completed. Their purposes were (1) to gain an impression of how the students normally work, and what motivates them to work, and (2) to gauge the effect of the case-based teaching and the weekly assignment on the student motivation, preparation and enjoyment. All students present participated.
- A focus group interview was held at the end of the course with four volunteers from the course. The interview revolved around motivation to work, and lasted 39 minutes. As the interviewees were volunteers, we assume that these were engaged students who enjoyed the course, and that they are not representative of the student population as a whole. They do, however, tell us something about what makes strong students enjoy and work hard on a course.
- The course evaluation consisted of an optional online questionnaire. Again, we cannot assume that the evaluation is representative of all students.

Results

The evaluation shows two main findings. The case-based teaching captures the students' interest and helps them engage in and understand the theoretical material, but it does not make them prepare more for lectures, see figure 8.1. The interview suggests this might be because the students are invariably pressed for time with compulsory graded assignments, which they prioritize higher than preparing for lectures, or even doing assignments that only require passing.

> "I had Datanet at the same time, where you had to get two assignments accepted, and we just made them two days in advance because we knew we could resubmit them after being told what was missing. Here [in Data Analysis] we knew from the start that they [the exercises] were the basis for our grade, so you know you have to work just as hard on all of them in order to pass the course, and then this became the interesting [course]."

Another reason is that lectures seldom require preparation (perhaps because students are known not to prepare, see figure 8.2), and the students report that preparation is not worthwhile:

> "Whenever I read the course literature, the lectures tend to become trivial."

The second main finding is that well planned weekly assignments actually work well in forcing students to work and engage in teaching material, see figures 8.3 and 8.4(c), and in the final evaluation they were reported as either "good, but challenging" or "wildly exciting and fun" by 73 % of the students (Fig. 8.4(a)). The work load was evaluated as suitable by the students who completed the course (Fig. 8.4(b)). The participants in the focus group interview, who are assumed to be among the more resourceful students, describe their most enjoyable classes as difficult, hard work, with a good balance between theoretical understanding and applications.

> "... it is the coupling of theory and practice. We made this exercise with hands [in Data Analysis], where we found the average hand. We made 5 pages of mathematical computations and then an implementation that was 5-10 lines, that could compute this thing that we had sat and done by hand for a really long time. That you can combine such complicated theory and in the end get something very beautiful, that is quite fascinating, I think."

> "The course in operating systems was incredibly exciting, incredibly difficult, but incredibly exciting. I like making things that people can use, and everybody needs an operating system."

> "I sometimes think it can be fun just because it is something to learn. Math is like that for me; I usually start out slow, where I read a bit and get started. Then after about four weeks I start to understand things, and it starts to be interesting, not so much because I discover that I can use it for something, but because it is a lot of fun to learn and see that you can actually solve this equation or make this proof. I don't have the idea that I will use it for something when I'm in the situation. For instance, when you learn about integrals... but then later, you discover that you actually use them for a lot!"

Based on the interviews, questionnaires and evaluations, the use of exercises to make the students work thus seems like a promising strategy.

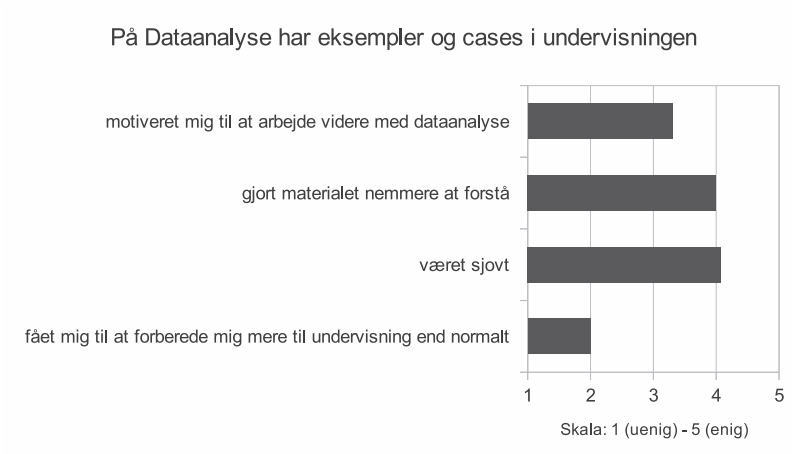

Fig. 8.1. In the Data Analysis course, case-based teaching made the subject more fun and more easy to understand. These effects were stronger than the effect on motivation to work with data analysis. (Translation: In the course Data analysis, cases and examples in the teaching have motivated me to work more with data analysis, made the material easier to understand, were fun, made me prepare more for class than I normally do. Scale: 1 (disagree) – 5 (agree).)

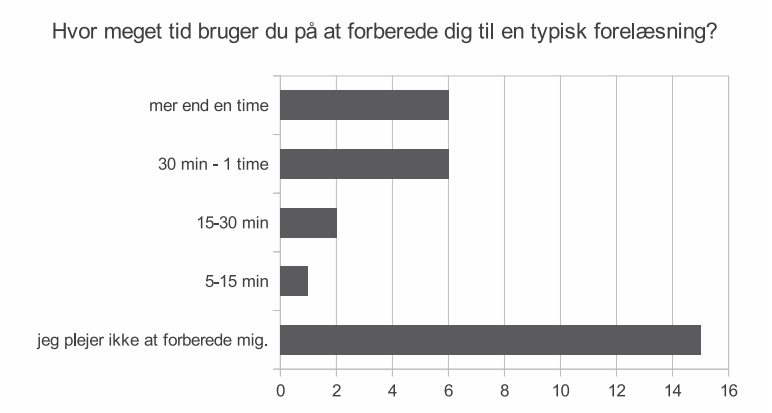

Fig. 8.2. From the start, the class was bimodal when it came to preparation for lectures. About half the class would prepare relatively well, whereas the rest would not prepare at all. (Translation: How much time do you spend preparing for a typical lecture? More than 1 hour, 30 min – 1 hour, 15 – 30 min, 5 – 15 min, I do not prepare.)

Discussion

The effect of cases on student preparation might be improved by strengthening the link between cases, lectures and weekly assignments. The weekly assignments were scheduled for the week after the corresponding lectures, for the material to settle. As a result, the students were constantly one week behind. This also affected the weekly ungraded exercises with a teaching assistant, that were intended to prepare for the following week's assignment. As the course progressed, these exercises were entirely neglected. The problem was that the deadline for the current assignment was the same evening as the exercise, and these classes were almost exclusively used for working with the current assignment. Due to the tight link between the graded assignments and the students' decision to work with course material, there should be minimal time between the introduction of material in the lecture and the students' need to use the material in a graded exercise.

On the other hand, the well-designed graded assignments had a good affect on spurring the students to engage in the course topic; however, a number of students dropped out of the course, and we link this directly

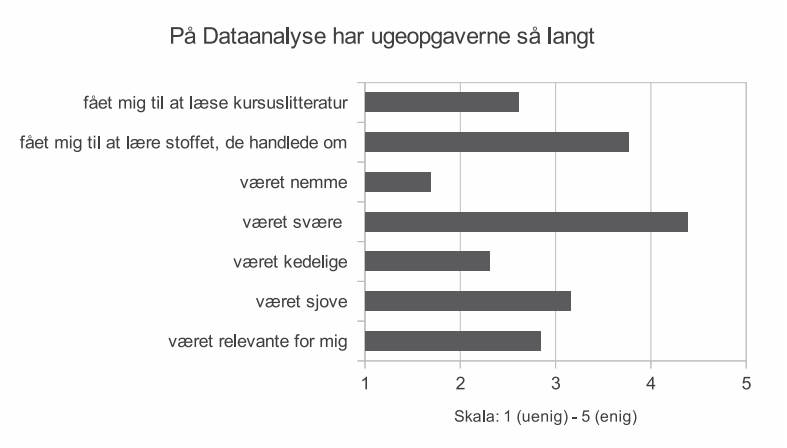

Fig. 8.3. The weekly assignments proved very useful in motivating students to work; they were, however, also perceived as difficult. This questionnaire was answered immediately after the second, most difficult, assignment. (Translation: In Data analysis the exercises have so far made me read course literature, made me learn the relevant material, been easy, been hard, been boring, been fun, been relevant for me. Scale: 1 (disagree) – 5 (agree).)

with the high work load in weekly assignment ♯2. These findings suggest that we should not be afraid to make the students work for good grades; we should rather be afraid of making decent grades unrealistic.

The requirements for passing a course, getting a good grade, and – perhaps – getting special recognition in addition to a good grade, should be made completely clear from the start. It should be possible for a strong student to get a top grade within the intended work load of a course, but there should also be extra challenges for those who want them, and there should be some sort of acknowledgement for those who make an extra effort.

> "In our very first programming course, there were these extra exercises where the teacher had said I'll give a beer or soda to the best solution. That would work really well, to have assignments that you can do within reasonable time, and then extra exercises, where you could say I have time this week and this topic is super interesting, so I'll do the extra assignment and see whether I can get the best solution. I think that seems really, really good."

Jeg synes at ugeopgaverne var:	
Irrelevante og dårlige	0%
Kedelige	18,2%
OK	9,1%
Gode, men krævende	54,5%
Vildt spændende og sjove	18,2%

(a) Translation: The weekly assignments were irrelevant and poor, boring, OK, good but challenging, wildly exciting and fun.

Jeg oplever arbejdsbyrden på kurset som:	
Alt for lille	0%
Lidt for lille	0%
Passende	36,4%
Lidt for stor	45,5%
Alt for stor	9,1%
Ved ikke	9,1%

(b) Translation: The work load was much too low, a little too low, suitable, a little too high, way too high or don't know.

Ugeopgaverne har tvunget mig til at sætte mig grundigt ind i undervisningsmaterialet og forelæsningsslides:	
Helt enig	54,5%
Enig	36,4%
Hverken enig eller uenig	9,1%
Uenig	0%
Helt uenig	0%

(c) Translation: The weekly assignments forced me to thoroughly engage in course material and slides. Completely agree, agree, do not agree or disagree, disagree, completely disagree.

Fig. 8.4. From the course evaluation, which was answered by eleven students.

One potential pitfall with optional additional exercises is, however, that optional work will easily be sacrificed in competition with more pressing compulsory exercises. One potential solution might be to offer some sort of official recognition for those students who do make an extra effort to do optional work, for instance an extra distinctive diploma or honors version of the course which gives an extra motivation for prioritizing challenging additional tasks.

Conclusion

In this project, two strategies for increasing student activity outside the lecture have been planned, implemented and evaluated. The first strategy, case-based teaching, did not affect student activity, although students reported that this type of teaching made the course, and in particular the theory, more enjoyable and easier to understand. The second strategy, strategic design of weekly assignments, was, however, very efficient. Future work includes fine-tuning the use of assignment design to keep the positive effect on strong students while making the assignments more accessible to students with a weaker background, lower motivation or less time to spend. This includes, in particular, an investigation of the effect of extra assignments for engaged students in competition with other demanding courses.

Part III

Stimulating student activity and deep learning

9

Naturgrundlaget 2 – activation of students in large classes

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Introduction

Traditionally, teaching at universities is often a one-way communication form where students are listening passively to the lecturer who on her part is trying to get the knowledge across to the students. According to Biggs & Tang (2007) most people learn about 20 % of what they hear and about 70 % of what they talk over with others. During a lecture the students' attention drops after 10-15 minutes, but a short rest or activity may increase attention again (Bligh 1998). With that in mind, one can ask why it is that the majority of teaching at universities is still one-way communication from the teacher to the students, knowing that the concentration drops during the lecture and that it encourages surface approaches to learning. Studies have shown that changing the lectures from a one-way communication form to a more student activating form can support deep approaches to learning (Mazur 1997, Trigwell et al. 1999). Last year, I gave my first two lectures, and I was doing it the classical way of teaching: one-way communication. Why? I have been taught in that way myself and by looking at other teachers, many are teaching in more or less the same way. It has been a great eye-opener for me to participate in the Introduction to University Pedagogy (IUP) course and I have been inspired by reading the KNUD project by Schneider (2007), Biggs & Tang (2007) and Mazur (1997). I have reflected on my teaching last year and started thinking; how can I change my lectures in such a way that students will be more active during the lecture? – based on the constructivism theory emphasizing that "learners construct

knowledge with their own activities, building on what they already know" (Biggs & Tang 2007, p.21).

Focus

The focus in this project was to try out and introduce different kinds of teaching and learning activities (TLA) in my teaching that could support the intended learning outcome (ILO), sharpen the students' attention during the lecture and support deep approaches to learning.

- How can we do that in large classes when the curriculum that has to be covered is on a basic level, and it is to be expected that the students' previous knowledge will be at different levels?
- What kind of teaching and learning activities will be appropriate leading to the ILO?

Course

I participated in teaching in the course "Naturgrundlaget 2" (Natural Resources 2 – Ecology and Biodiversity) which is a new 15 ECTS course running in blocks three and four with a written examination after each block. Before 2012 it was a 7.5 ECTS course with a focus on plant classification and identification, and vegetation ecology. These topics are still part of the new course, but the new course also includes interactions between plants and soil and overlaps with another course including written reports (in block three).

The course had 76 students. In block three, I gave three out of the eight lectures in basic ecology. In block four, I gave two lectures and exercises in vegetation ecology.

Before the teaching started in block three, I was a bit concerned about the large curriculum, the many different topics that had to be covered, several textbooks, two large written reports and many different teachers. Would it be possible for the students to overcome all that in only one block and for my part of the teaching (three-eights of basic ecology): Would the students find basic ecology relevant for their education and future employment at all? I did not have the same concern regarding block four. Block four still had many teachers, but the topics were more alike.

Teaching in block three – basic ecology (topics):
Lecture one: Photosynthesis, respiration, nutrients, fundamental and realized niche, plasticity
Lecture two: Population demography and growth models
Lecture three: Plant competition

Teaching in block four - vegetation ecology (topics):
Lecture one: Heath, grassland
Lecture two: Weed in arable land, ruderal habitats, small biotopes, roadsides, hedges

In block three, I asked the students to complete a questionnaire twice (one covering lecture one and one covering lectures two and three). In block four, they were asked to complete one questionnaire covering two lectures).

Method and teaching

With the constructivism theory in mind (Biggs & Tang 2007), my strategy was that I would start the lecture by asking the students if they knew anything about the subject of the days lecture or if they thought that they were able to explain the subject to their next-door neighbour. After that I would introduce the theory, interrupted by questions like: Why. . . ?, How. . . ?, Can you explain this figure? and so on, and small exercises. Some of the questions were (a) questions directly to the full class, (b) questions where students had to think for themselves first, then discuss their individual answers with their next-door neighbour for a few minutes, followed by a discussion in plenum (think-pair-share), and (c) questions or exercises that needed longer than a few minutes to solve and discuss, but the students were still working in groups of two to three persons, and the answers were finally discussed in plenum. The didactic game was not the same in all situations, but an example could be (Winsløv 2006, after): devolution (teacher presents the question), action (students work on their own), formulation (students discuss with their neighbour), validation (students present solutions in plenum), institutionalization (teacher presents official knowledge).

The intended learning outcome for the first part of Naturgrundlaget 2 is mainly on a low level on the SOLO taxonomy, e.g. describe or identify (Biggs & Tang 2007, Figure 5.2 and Table 5.1). I had to take that into consideration when asking questions (TLA), knowing that it does not support

deep approaches to learning. The students should be able to relate theory in ecology of knowledge in interactions between plant and soil. To support deep approaches to learning, I decided to include some questions or exercises on the relational level on the SOLO taxonomy (e.g. explain).

Apart from supporting deep approaches to learning and keeping the students awake during the lecture, another purpose of asking questions or giving exercises during the lecture was to motivate the students to take an active part in the lecture, to give the students an opportunity to work with the theory, to obtain a more relaxed atmosphere in the classroom and to create a more dialogue-based teaching. The questions and exercises gave me an opportunity to test whether the students understood the theory I had just gone through or not.

Teaching in block three

In block three, I made hands-out to each lecture where difficult theory and terminology were explained in details to (1) support the PowerPoint presentations, and (2) help the students to understand difficult topics. The working questions and exercises were handed out to each lecture. To each lecture I included three or four exercises.

I started the first lecture by asking the students if they had read the curriculum of the day – most of them had (Fig. 9.6). After that I asked if they knew what photosynthesis is about. They all nodded. When I asked them to explain photosynthesis to their next-door neighbour it was a bit more problematic. So after buzzing for a while (none of the students wanted to explain photosynthesis to the rest), I took over and explained what photosynthesis is all about and introduced three different photosynthetic pathways (C_3, C_4 and CAM) as an introduction to the first exercise. At this point in the lecture, the students should be able to work with the first exercise (Fig. 9.1), so I introduced the first of three small pre-planned exercises in that lecture.

In this exercise they should find out and discuss with their next-door neighbour which of the leaves in the figure was a C_3-plant and a C_4-plant. (Answer: Photosynthesis takes place in the chloroplast. In C_4-plants photosynthesis takes place in the mesophyll cells and in the bundle sheath cells, whereas in C_3-plants photosynthesis takes place only in the mesophyll cells (no chloroplasts in the bundle sheath cells)). The students found this exercise difficult. That surprised me because I thought that they would have found this exercise easy. Then we went on with more theory, and I introduced the next exercise to them (Fig. 9.2). Again, they should discuss with

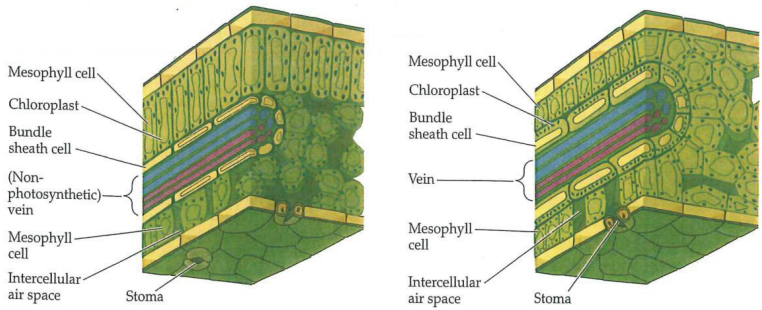


Fig. 9.1. Leaf from a C_3-plant (left) and from a C_4-plant (right).

their neighbour why (1) trees (at least most of them) are green during summer and (2) their colour changes in the autumn. This exercise was easier for the students to answer. Answer: Green in the summer because of the content of chlorophyll in the leaves. Most of the green light is reflected, and we perceive the leaves as green. In autumn the temperature is low and the light intensity reduced, and the production of chlorophyll is less than the breakdown. The red and yellow colour in autumn is caused by other pigments in the chloroplast, and these are visible when the chlorophyll is broken down.

After the lecture, I asked the students to evaluate my teaching (Fig. 9.6). About half of the students found that both the lecture and the exercises were at an appropriate level. 50 % found the lecture too difficult and 37 % found the exercises too difficult. Some of the students commented that they did not get enough instructions to solve the exercises.

The next lecture was built in the same way as the first with theory, questions and exercises. In this lecture, I had asked the students to solve an exercise before the lecture. The reason for that was to force the students to read the textbook before the lecture to be able to solve the problem and to support deep learning. To be sure that all students were able to solve this exercise (and the other exercises in this lecture), I tried hard to explain what the exercise was all about and gave them all necessary data and instructions beforehand (the exercise was about exponential growth of a population). My hope was that one-third of the students would have tried to solve the exercise at home. The original plan was to ask the students to work in small groups with the exercise. Each group should include at least one person

Fig. 9.2. Leaf colours in summer and in autumn.

who had tried to solve the exercise at home, and this person should help the rest. One day before my lecture, the students had a deadline for a written report in their other course, resulting in only two or three having tried to solve the problem. Nevertheless, I asked the students to solve the problem in smaller groups because it was a part of the planned TLA – knowing that they needed longer time than i had initially planned. The exercise was no more difficult than mathematics on the highest level in high school (which is an entry requirement for the course), however some of the students had problems solving this exercise – probably because they had not read the curriculum before the lecture. My first intension was that the students, by turns, should go through the questions at the blackboard. Because they used more time solving the problem than planned, and only a few had read the curriculum for the day, I had to go through the questions.

In the third lecture, I had tried to find some exercises at a lower level than the two first lectures. I started the lecture by asking if they knew what plant competition is about and what plants compete for. These questions were to start the dialogue and to motivate the students to take an active part in the lecture from the beginning – they came up with very good suggestions to the questions. Figure 9.3 is an example of one of the exercises from this lecture. The students were asked to plot the yield for maize grain, grown at different crop densities and levels of nitrogenous fertilizer, and discuss the influence of crop density and fertilizer level on yield with their next-door neighbour. After some time, I asked if someone would like to explain the figure to the rest of the class. The students got feedback to their answers, and finally, I explained the figure to the students.

In the end of this lecture, I had an empty slide and asked the students to review what they had just learnt. This activity was included to give the students an opportunity to ask questions and to explain, and we briefly discussed their suggestions. I wrote the points down on the slide and compared it to my own summary. There was a very good accordance between the two slides.

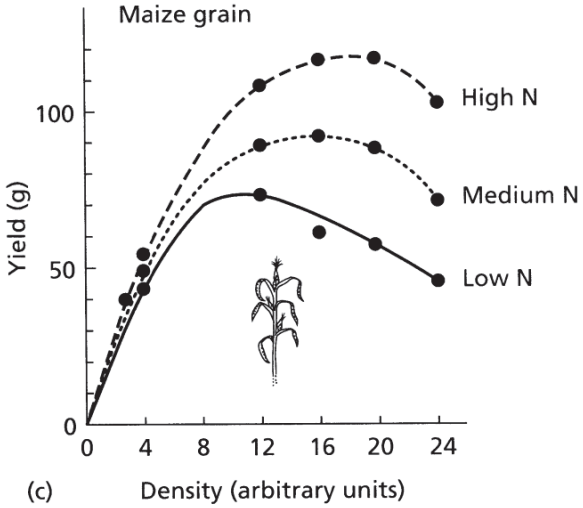


Fig. 9.3. Grain yield of maize grown at five crop densities and three nitrogenous fertilizer levels.

Teaching in block four

In block four, I supposed that the students would find the topics more relevant. In this block, the lectures were followed by exercises with the same topic as the lecture. Because of the following exercises, I had changed the teaching in both lectures from small exercises to be more dialogue based than it was in block three. In the exercise after the first lecture, the students were going to make a kind of puzzle and to identify living plants typical from the heath. In the second exercise, the students were introduced to a field experiment (relevant for the exercise), and afterwards they were asked

to collect and identify as many weed plants and plants from the hedges as possible.

In the first lecture (heath and grassland), and I started the lecture by asking the students: Do anyone of you come from Jutland? Some of the students did, and I asked them to explain to the rest what a heath is (why is a heath more common in Jutland than in the rest of Denmark, which kind of vegetation do we find and questions like that). The rest of the lecture shifted between theory and open questions and dialogue. During the lecture, the students were introduced to figure 9.4 which was a part of the following exercise (puzzle). In this exercise, the students were asked to place cards – with pictures (like figure 9.5) of the mentioned plants in figure 9.4 – in the right place (no plant names on the cards). Some of the plants were part of the examination requirements. For these plants, the students should make a list with the characteristics and the names of both the plant family and the species (ILO-TLA). At the following written examination, one of the main questions dealt with heaths and the TLA from figure 9.4.

The second lecture (weeds, small biotopes and hedges) took place at the university's research farm, Højbakkegård. I used almost the same method as the first lecture, starting the lecture by asking the students how to define weeds. Early in the lecture, I introduced the students to the field experiment in which they were going to collect weed plants during the exercise. The introduction to the field experiment was more or less case-like. The students were asked to consider the following problem: Politicians have decided to (1) reduce the use of pesticides, (2) increase the area with organic farming, and (3) reduce the emission of greenhouse gases (real goals in the Grøn vækstplan).

The case: How can we help the farmers to fulfil these goals?

Some of the slides are translated to English and listed in Appendix A. The slides were presented as open questions to the students, discussed in plenum and followed up by examples from the real world.

The rest of the lecture shifted between theory and dialogue-questions, interrupted by circulating living plant material in the class, giving the students an opportunity to see the plants we had just been talking about in real life and not only on a slide.

In the following exercise, all the plants collected from the field and the hedges should be arranged in the right plant families. Finally, the plants were gone through together with one of the teachers to be sure that all the students knew the right names of the plants.

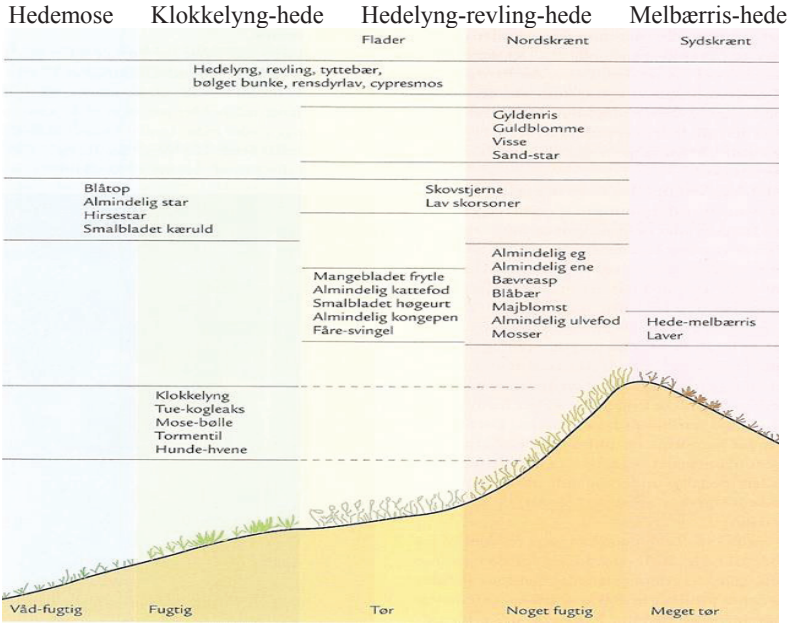


Fig. 9.4. Different plant species are related to specific areas in the heath – depending on topography and humidity conditions.

Evaluation

To evaluate and improve my own teaching, I asked the students to complete a questionnaire after some of the lectures in block three (Fig. 9.6) and after the last lecture in block four (Fig. 9.7). The evaluation includes my own reflections and comments from my departmental and pedagogical supervisors, too.

My concern before block three about the large curriculum, the many different topics, several textbooks, written exercises and many different teachers was confirmed by the following course evaluation after block three (non-official questionnaire worked out by the course coordinators), where not only these things were criticized but also the basic ecology (among other subjects).

My own evaluation after block three showed that 50 % of the students found the first lecture difficult and 37 % found the exercises difficult (Fig.

Fig. 9.5. Card example to the puzzle showing a detailed drawing of common heather (*Calluna vulgaris*) on one side and a picture on the other side of the card (no plant name on the card).

9.6). Though many students found the exercises difficult, 95 % liked being asked questions during the lecture, 74 % thought that they learnt more because they had to answer questions or exercises, but only 26 % thought they were more active because they knew that they were going to answer questions during the lecture. I had expected a higher percentage here. Some of the comments to my teaching were that I should decrease the number of slides, that I spoke too fast and not loud enough and that they needed more instruction for the exercises. For the next two lectures, I borrowed a microphone, I tried to speak more slowly, and I was very much aware of explaining what the exercises were about and to give all necessary information. According to figure 9.6, more students found both lecture and exercises easier in lecture two and three than in lecture one. I still have to work on finding the right level. A test before the first lecture, checking their previous knowledge of the topics, could have been a possibility to adjust my teaching to their knowledge. Because the students had a written report due the day before my lecture number two, only 35 % had read or looked over the curriculum for the day and only a few had tried to solve the exercise – as I had asked them to do – before the lecture. This could explain why

A. Did you read/look at the curriculum for today before the lecture?			
Lecture no	Yes	No	
1	61	39	
2	35	65	
3	27	73	
B. Did you find the lecture difficult?			
Lecture no	Easy to appropriate	Appropriate to difficult	Useless answers
1	50	50	
2	60	30	10
3	92	8	
C. Do you like being asked questions during a lecture?			
Lecture no	Yes		
1	95		
D. Do you think that you were more active during the lecture because you knew that you were going to answer questions?			
Lecture no	Yes	No	Do not know
1	26	58	15
E. Do you think that you have learned more because you had to answer questions?			
Lecture no	Yes	No	Do not know
1	74	13	13
F. What do you think about the exercises (degree of difficulty)?			
Lecture no	Easy to appropriate	Appropriate to difficult	Other answers
1	58	37	5
2	70	15	15
3	86	0	14

Fig. 9.6. Extract of some the results from the two questionnaires the students were asked to complete during block three (after lecture one (38 answered) and lecture three (37 answered)). The numbers in the table are percentage of usable answers for each question (some of the possible answers to the questionnaire are pooled (question B and F)).

15 % of the students found the exercises difficult in lecture two. Though the students had not worked on the exercise at home, they worked actively with the exercise in small groups in the class. The exercise did not turn out exactly the way I had expected. We spent more time than planned to solve this exercise, but it will not prevent me from asking students to solve exercises at home in the future. I have learnt that it is important (1) to coordinate homework, both within the course and with other parallel courses, to avoid loading the students with unrealistically high homework pressure, and (2) to include extra time within the lecture to solve the exercise (in case the students have not looked at the exercise at home).

Instead of sitting passively listening, the exercises and learning by doing did increase the students' attention because they had to work with the theory I had just gone through. Most of the students liked questions or exercises

A. Did you like the textbook (Vegetationsøkologi)?			
	Yes	No	No answer
	61		39
B. Did you read/look at the curriculum for today before the lecture?			
Lecture no	Yes	No	
1	41	59	
2	100		
C. Did you find the lecture difficult?			
Lecture no	Easy to appropriate	Appropriate to difficult	
1	100		
2	100		
D. Did you learn what you expected?			
Lecture no	Yes	No	Do not know/no answer
1	71		29
2	78		22
E. What do you think about the exercises?			
Lecture no	Number of students that made comments.		
1	13 found the exercise from good to very good, 4 found that the quality of the some of the pictures was not good enough, 2 found it difficult because they did not know so many plants, 1 would have found the exercise more relevant if it had only included curriculum species, 2 that there were too many pictures, 1 did not have time enough to the hole exercise but liked this kind of exercises.		
2	15 found the exercise from nice (cosy) to very good, 1 found it a bit boring but liked to see the research area, 3 would have liked more time, 1 that it was nice that they had the opportunity to ask questions and get answers during the exercise, 2 that it was nice to collect plants themselves, 3 liked the summary of the plant names in the end of the exercise.		

Fig. 9.7. Results from the questionnaire the students were asked to complete after the second lecture in block four (18 answered). The numbers in the table are percentage of answers for each question except question E, where it is the number of students commenting the question (some of the possible answers to question C are pooled).

during the lecture and felt that they learnt more. It is my impression that all students were active in solving the exercises and many – though not all – were active when they had to participate in the following discussions in plenum. In the future, I will continue including short exercises in my teaching to support the ILO, but I will try harder to find subjects more relevant to the students' field of activity. A challenge I see using (small) exercises during the lecture is that (1) the flow of the lecture is interrupted (which of course can be the intention, to revive the students' attention) and it can take some time to get the attention and the students back on track again, (2) in large classes it can be difficult to get around and help all groups

if you are the only teacher, and (3) students need different amounts of time to solve problems – fast students or groups can disturb or cause stress for slower working students. Offering the fast working students and groups extra questions could be a solution – the answers to be explained by the groups to the rest of the class later in plenum. This could prevent private talking, surfing on the internet and walking in and out of the class, but one should have in mind that not all students see extra questions as an advantage.

Changing the teaching from teamwork exercises in block three to a more dialogue based teaching with many open questions to the whole class in block four worked very well, and the atmosphere in the class was relaxed. It is my impression that the students found the topics easier, more interesting and relevant to them. More students than I had expected participated in the discussions. I think the reason is that none of the students found the lectures difficult in block four (Fig. 9.7) and therefore they were not reluctant to participate in discussions and in answering questions. Early in the lectures, the students were presented with the ILO and introduced to the TLA that followed later in the exercises (Fig. 9.4 and 9.5, and the case). This made a good coherence between the lectures and the exercises.

Conclusion

Introducing questions and small problems that have to be solved during a lecture does involve students more in the lecture. The strategy gives the students the opportunity to think and work with previous and new knowledge by discussing problems with other students and the teacher. It also reveals what was unclear in the lecture. I felt that the students were more active and their learning was changed from passive (surface) learning to a more active and deeper learning. A test before the first lecture in block three could have matched my teaching with the students' previous knowledge better in this block and increased the students' output of the teaching. This should ask the students to review what they have learnt during a lecture, give the students a possibility to think, reflect and explain in their own words what they think was the learning outcome for the lecture. I will definitely use this again in my lectures. I think that the students were more active than usual in this course. Despite that, I am not sure that it is realistic to believe that all students will be actively involved in all teaching during a lecture in classes with many students. The students expressed that they liked being

asked questions during the lecture and that they learnt more. My personal impression is that (1) all the students worked with the exercises though some of the exercises were a bit too difficult, (2) more students participated in discussions when the topics were easier, or they found the topics more relevant, and (3) the contact among the students were closer, and the atmosphere in the class was more positive and relaxed when the teaching was more dialogue based. My experience is that it is very important to think and reflect on which kind of TLA is appropriate in a given teaching situation and to explain in details what the exercises are about. I will continue my teaching method of switching between questions, discussions and small problems. To increase the number of students taking part in the lecture, I will start the lecture with some easier questions, and I will include more time in the lecture for students to think and work with questions and small problems.

A Case from lecture two in block four

"Case" and introduction to field experiment

"Grøn vækst plan"

Goals:
Reduce the use of pesticides
Increase the area with organic farming
Reduce the emission of greenhouse gases
→ 70 % of the pesticide use are herbicides!

How can we help the farmers to fulfill these goals?

What can the farmer do?

Heat treatment or mechanical weed control

Alternative

Increasing the competitive ability of the crop

No reduction in emission of greenhouse gases

Plant competition

Cereal crop plant advantage:

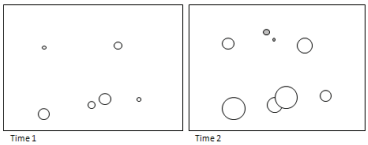
1) Crop seeds/seedlings are usually larger than weed seeds/seedlings
2) Crop plants normally germinate quickly after sowing

"Size-asymmetric competition":

Larger plants often have a disproportionate advantage in competition with smaller plants, i.e. that larger plants receive a disproportionate share of resources relative to their size than smaller individuals.

Plant competition

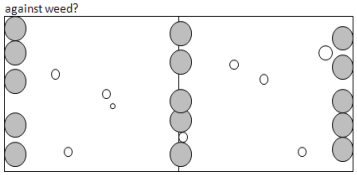
Above ground competition - light



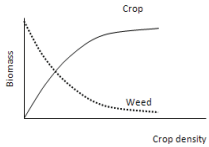
Part of a cereal crop field

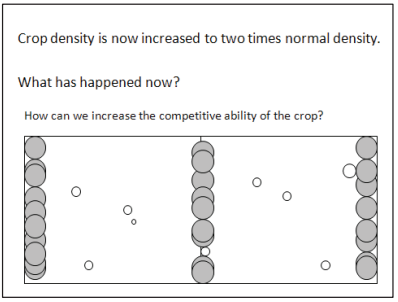
White circles are weed plants. Grey circles are crop plants sown at **normal crop density in a row pattern.**

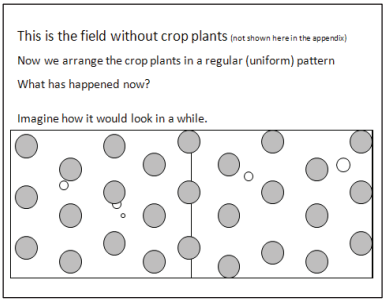
Is the crop a good competitor against weed?
What do you expect will happen if the farmer is not allowed to spray against weed?

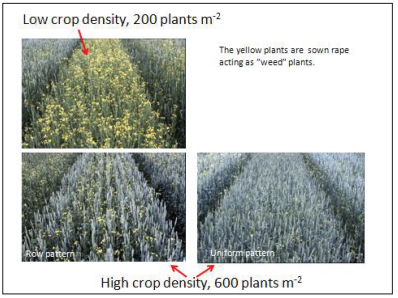


Relationship between biomass and crop density









(This is not the original slide but a combination of three slides)

10

Teaching competences within a foreign discipline – Introducing protein science to pharmacy students

Kasper D. Rand

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Background – why should students at a School of Pharmacy learn about proteins?

In September 2011, I joined the Department of Pharmacy and in addition to my other teaching assignments I was appointed to a faculty work group in charge of producing a report that surveyed and critically assessed the current status of teaching within biological or protein-based drugs (biopharmaceuticals) at the School of Pharmaceutical Sciences (van de Weert et al. 2012). While working with the work group and attending the University Pedagogic Course, I started thinking about the inherent problem of introducing the complex topic of biopharmaceuticals to pharmacy students who had little or no prior background in protein science. How does one minimize surface learning and ensure that students attain actual competencies within such a challenging new discipline?

Teaching at the department of pharmacy has traditionally revolved around the pharmaceutical science of small molecule drugs. In the last two decades there has however been a dramatic increase in the number of large molecule drugs coming to the market. Most of these are based on naturally occurring protein macromolecules (biopharmaceuticals). At present, about 25 % of newly approved new drug entities are biopharmaceuticals and their proportion in the global pharmaceutical development pipeline is steadily increasing. Thus, they comprise a significant number of the present and future novel drugs reaching the market. This means that students in pharmaceutical sciences should not only be aware of their existence, but also know

about their properties as drugs, how they are discovered, analyzed, developed, modified, formulated and approved. Simply put, the students need to know everything worth knowing about proteins from a pharmaceutical perspective. Currently, however, there is insufficient teaching about proteins at the School of Pharmacy and in particular no course deals with attaining practical competencies with proteins in a laboratory setting.

From a teaching standpoint, learning and attaining practical competencies with protein drugs represents a significant paradigm shift relative to small molecule drugs. Proteins require a fundamentally new knowledge base, a different set of practical skills, in short, a different scientific culture. My thoughts on this subject were inspired by (Wood 1996, p. 132-7):

> "To learn to use tools as practitioners use them, a student like an apprentice, must enter that community and its culture."

Thus, in order for pharmacy students to learn real-world competencies with protein-based drugs they needed to adopt or at least understand a different way of thinking, a way of thinking embodied by the discipline of protein science. True in-depth understanding of the pharmaceutical development of biopharmaceuticals thus required the students not only to learn about a new topic but also embrace a foreign scientific culture.

From a practical viewpoint, this presented a significant challenge. As the newest addition to the faculty, I had only limited sway to make changes in the existing course programme and even less room for manoeuvre concerning the introduction of new courses. I therefore decided initially to survey the status quo of teaching in biopharmaceuticals at the department (attached in teaching portfolio) and use select teaching assignments to gain first-hand experience with the challenges of teaching proteins to pharmacists and use any attained knowledge to guide further steps.

Starting small: new lectures in existing courses

Plan

I identified two scheduled double lectures that I was to teach on two different existing courses. I judged that these offered a good opportunity to introduce key theoretical aspects of protein science to students and evaluate the outcome of my teaching. In both cases, the lectures had been added to the existing courses upon my own initiative and generously accommodated by

the person responsible course. The first teaching event was a double lecture in a PhD course entitled, "Analytical Methodologies in Protein Formulation". The second teaching situation was a set of lectures on related topics in the PhD course, "Mass Spectrometry Coupled to Separation Techniques" in Bioanalytical Chemistry.

I aimed to introduce the discipline of protein science in the lectures by the following teaching strategy:

- Be approachable: As I was a guest lecturer at the existing course, I would take five minutes at the beginning to clearly introduce myself, encourage students to ask questions anytime and also to contact me after the lecture if curious for more information.
- Why am I here? I would spend the first three slides directly identifying why this topic was directly relevant to the student attending this particular course. Studies show that the first 20 minutes of a lecture is the time frame where students are attentive (Middendorf & Kalish 1996). It was therefore critical that my first slides would get students curious to the new topic at hand by outlining the relevance of the material to their background.
- Be succinct: For each lecture, I made a set of 70-80 slides concerning the subject matter. I then spent a considerable amount of time looking over the slides and removed about half of them. This was done to ensure that each individual slide was justified as need-to-know material and not just nice-to-know material. It also ensured that I could spend more time on select parts of the material that were key for deeper learning.
- Use practical real-world examples: I would go to great lengths to identify and use real-world practical examples that were relevant AND representative of how the students could apply this new discipline in a pharmaceutical setting.
- Student activation and peer instruction: Each 15 minutes I would introduce a slide with a quiz (see Appendix A for examples) to break up the lecture into shorter segments, to shift the focus and enable students to participate. The students were given five minutes to discuss the question or come up with a solution with the person sitting next to them. Then I would ask if any had an answer and hopefully try to start a discussion.

Evaluation of outcome

Through a well-defined focus coupled with the use of peer instruction and student activating exercises as inspired by Mazur (1997), I aimed at initiat-

ing deeper learning processes. I hoped that I could achieve this goal despite (1) having only the short time frame of two lectures and (2) being tasked with teaching a discipline that was foreign to the students. To evaluate my teaching and specifically to gauge my success in inspiring students' interest and some degree of deeper learning, I attained a copy of the course evaluation sheet for one of the courses. This evaluation sheet was however written in advance by the course responsible and had not permitted a specific evaluation of my two lectures. Irrespective, I did find that 43 % highlighted my lectures in the evaluation form and of this subgroup all were in positive and enthusiastic terms. To evaluate if I had managed to do more than spark student curiosity, however, I emailed all the students on the course exactly one week after my two lectures and asked them to fill out a very simple questionnaire (Appendix B). The sole purpose was to specifically assess if the students remembered the correct answers to the three quiz events during one of the lectures. As these three quiz questions had been designed to sum up the most important parts of the combined lectures, the ability of the student to still remember the answers would be a somewhat crude indicator of the degree of deeper learning I had managed to induce in the students. I note in this context that such a simple approach is not the exhaustive evaluation needed to accurately assess deeper learning outcomes. Also this would be difficult to achieve based merely on two lectures. My evaluation merely served to gauge whether students achieved a more relational understanding of the subject matter, with an ability to explain and analyse causes as per the hierarchy of learning outcomes described by Biggs & Tang (2007). I managed to get replies from eleven students (approximately 40 %). A few had some suggestions for me to improve the lecture and 90 % appeared to have found the lecture both interesting and stimulating despite the foreign topic (see Appendix C for one example). Naturally, such conclusions should be taken with a grain of salt as they were replying directly to me and not in an anonymous manner. Thus I focused instead on evaluating their answers to the one week-old quiz questions. The results are shown in figure 10.1.

More than 80 % of the students were able to give the right answer to Quiz 1 and Quiz 2, even a week after the course. I was somewhat surprised by these finding. I had expected something closer to 50 % or perhaps even lower. Notably almost all correct answers also included a correct rationale for the answer, as detailed in their emails. This latter is also an important finding as this indicates that some degree of deeper learning was achieved. It appears that quiz questions can, if carefully considered, be an excellent stepping-stone for students to start to embrace the core concepts of a new

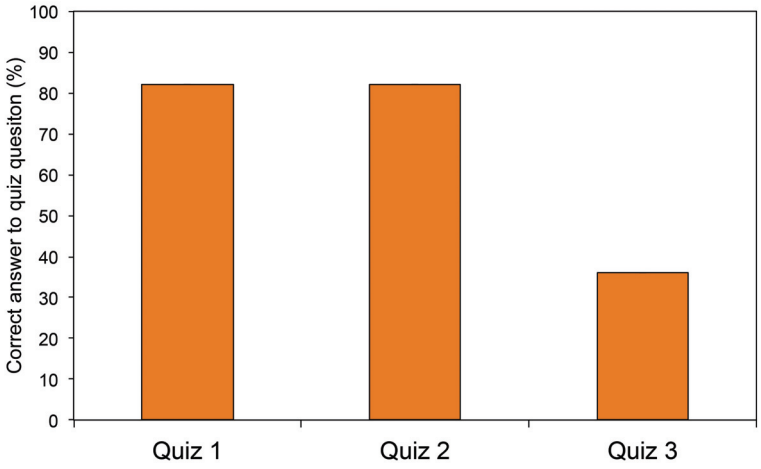


Fig. 10.1. Evaluation of the extent of deeper learning in a lecture. The chart indicate the number of correct answers in percent to quiz questions one week after the lecture.

and foreign discipline. This was supported by my evaluation of this lecture event. This has subsequently inspired me to use quiz questions as a component in all future lectures in particular to underline the key take-home messages within a new topic. Notably, less than 50 % of the students recalled the correct answer to Quiz 3. This is probably because this quiz was not so general and conceptual but rather relied on students having absorbed specific knowledge imparted to them earlier in the lecture. It may also be that this quiz was held at the end of the double lecture and thus the students found it harder to become activate and assimilate my teaching. Regardless, I will in the future use only simpler, conceptual quiz questions at the end of the lecture (perhaps replacing Quiz 3 with three more simple quiz questions thus dissecting the central point covered in Quiz 3 into smaller more digestible bits).

Starting small: new laboratory exercises in existing courses

Action plan

Laboratory work represents a crucial practical competency within most types of science including pharmacy. To my mind, practical lab exercises provides a unique venue for illustrating and setting theoretical knowledge in a scenario and context that encourages deep learning. I therefore welcomed the opportunity to design, implement and evaluate a new laboratory exercise on basic protein science that was accommodated into the bachelor's degree project of third-year pharmacy students. At the time, there were very few other laboratory exercises at the School of Pharmacy involving work with proteins. Thus this new exercise served as a timely opportunity for me to test, evaluate and refine future laboratory teaching concerning proteins within the Department.

To help the introduction of the new laboratory exercise I decided on the following teaching plan:

- Stimulate student interest: For each group (3 or 4 students) I would hold a 30 minutes pre-meeting where they were introduced to the background and relevance of the laboratory exercise. This pre-meeting also provided the chance for the students to ask questions and served to display gaps in student knowledge concerning proteins. I made several schematics and figures that explained the background of the exercise and the equipment used and hung printed copies of these on the wall in the laboratory for easy inspection by the students during the exercise.
- Make the students take ownership: Each group of students was encouraged to prepare samples of their own choosing that could be produced using a variety of basic experimental protocols. Experimental work in the lab centered on analysis of these unknown samples, which had not previously been analyzed by me. The results were therefore not predetermined. Through this approach, I hoped to enhance student interest in interpretation of the results from the lab exercise. To further empower the students, they were also given the opportunity to read original literature and to come by my office if they needed aid in interpreting results.
- Real-world relevance: The instrumental setup and work flow I designed for the laboratory exercise was implemented to closely mimic work flows in use in a real-world pharmaceutical research laboratory. It was emphasized to the students that while some of the equipment in use was

somewhat outdated the principles and procedures used in the lab exercise were very relevant to real-world applications. I also introduced the students to two software tools that are used routinely in professional protein analysis labs and encouraged the students to try to use this software independently to interpret their own results.

Outcome and student evaluation

To assess and evaluate my teaching and the design of the laboratory exercise, I had the students fill out an anonymous evaluation form after completing the laboratory exercise (Appendix D). I was very pleased to find that the students found the laboratory exercise very interesting as I had spent a considerable amount of time designing it for the same purpose. In the evaluation, several mentioned that the exercise had made them more interested in learning more about proteins and their role as drugs. Almost all students emphasized that the material was clearly and well explained to them with ample time to ask questions. Some mention that it would have been nice if the laboratory exercise had been part of a larger context, for instance, a designated course on protein science (at the time it was merely an add-on exercise to the bachelor project of pharmacy students). Only about 50 % had prepared prior to the exercise and thus many solely relied on what knowledge was provided to them during the pre-meeting. The considerable value of the pre-meeting on overall learning outcome was thus made apparent. I did however take up quite a lot of my time to meet separately with each group. If a larger body of students were to perform the lab exercise I would probably have to do the pre-meeting in the form of a lecture or tutorial for all groups. Further, to make students prepare more for the laboratory exercise, next year I plan to provide them with an assignment which needs to be completed by the pre-meeting and introductory lecture. The assignment will then be discussed at this meeting and the students will be expected to provide answers and participate. This assignment will be based on the use of the two software tools that the students will also use in the lab to interpret their own results. Thus, by introducing an assignment before the lab exercise the students will not only be forced to think about the lab exercise before hand but also become familiar with some of the tools that they will ultimately need to interpret results obtained during their ensuing lab work.

Going big: planning a new master's degree course

As a member of an inter-faculty work group on biopharmaceutical education, my coauthors and I produced a report in early 2012 on the status of education within biopharmaceuticals at the School of Pharmaceutical Sciences, University of Copenhagen (van de Weert et al. 2012). This report recommended increased teaching within practical aspects of pharmaceutical work with proteins and suggested the introduction of a new elective master level course that included a significant number of laboratory exercises.

The need for a designated practical course in protein science was also alluded to by some students in the evaluation form of the new laboratory exercise. To my mind, one can only achieve so much by patching one or two lectures or laboratory exercises into existing courses. While this is sufficient to familiarize students with the general principles of the new discipline of protein science, it will not be sufficient to fully equip pharmacy students with the competencies required to tackle tasks they will confront if they are to work with protein-based drugs in their professional career. Furthermore, it does not adequately illustrate the myriad practical challenges of working with large biomolecules in a laboratory setting. I have therefore begun over the last six months to plan how I may stitch my experiences from teaching within the last year into the seams of a new tentative master's degree course. This course will have the title "Purification and Analysis of Peptides and Proteins" and has tentatively been proposed as an elective course for master's students.

The planning of this course is still at an early stage and much work still needs to be done. I have set upon following the guidelines provided by Jakobsen (1999) with an emphasis on addressing, in turn, the following key points during the planning: (1) Teaching goals and competencies, (2) Student backgrounds, (3) Structuring of teaching material, (4) Structuring of learning processes, (5) Choice of evaluation and exam. I will herein only detail how I plan to make use of my recently acquired experience with teaching protein science to optimize teaching goals and competencies and the structuring of teaching material in this new course. The primary aim of this new course is to teach the hands-on skills and competencies required to work with proteins in a laboratory setting, an element that is currently lacking in the study programme of pharmacy students. To meet this goal, the course needs to be a practical course and will be built around a series of laboratory exercises. I have decided on an overall format for the course that

builds closely upon practices gained from introducing lectures and laboratory exercises in existing courses described earlier. Every laboratory session will be introduced by a lecture immediately beforehand to properly introduce and thoroughly go through the background of the laboratory exercise. To ensure that students prepare for each such grouped lecture or lab session, assignments will be given beforehand which will be quizzed and discussed during the lecture. I plan to organize and implement the lectures according to the guidelines outlined earlier in this report with emphasis on (a) student activation and (b) the relevance of the lecture to the ensuing lab exercise and real-world applications. For the laboratory exercises, students attending the course (estimated approximately 20-30) will be separated into groups of four or five students. Inspired by my experience from designing the previously discussed laboratory exercise, I will encourage student ownership and involvement in the practical work by giving each group an unknown unpurified protein sample at the beginning of the course. The basic overall goal of the practical course is thereafter to use the laboratory exercises to purify and find out as much as possible about the protein in their sample, using a range of experimental methods and techniques. As the course progresses, the students will be introduced to increasingly advanced methods and have the opportunity to apply these methods in a practical setting during the ensuing laboratory exercise. As each sample is different and unknown, it is hoped that the students will more easily identify themselves with their laboratory work and engage in motivated, critical thinking processes, instead of just following a preset sequence of laboratory protocols which is a pit-fall of some laboratory-based teaching (van de Weert et al. 2012). A further benefit of this particular structuring of the laboratory exercises, is that it quite closely reflects the real-world work procedure of a pharmaceutical scientist working in an analytical research lab. It is hoped that this laboratory course will impress on the students a list of specific highly relevant competencies within the broader discipline of protein science and additionally give the students basic know-how to tackle real-world challenges encountered during the development of biopharmaceuticals.

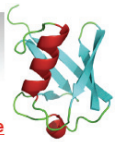
Perspectives

Planning a new master's level course is a momentous task and much work still needs to be done concerning crucial aspects of the design of the new course. However, I strongly feel that by evaluating my teaching practices

over the last year, I have become better equipped to be able to design and plan a good course. In addition to my own evaluation, the extensive feedback from both colleagues and my pedagogic supervisor upon supervising my teaching has greatly helped me to critically assess various teaching events. Most importantly, this has provided me with the basic tools to continually improve my strategy for encouraging deeper-learning processes in the students that I teach. I have become convinced that deep-learning processes, more than any other single teaching parameter, is critical to make students absorb the key aspects of a new foreign discipline and attain actual competencies within this discipline.

A Quizzes

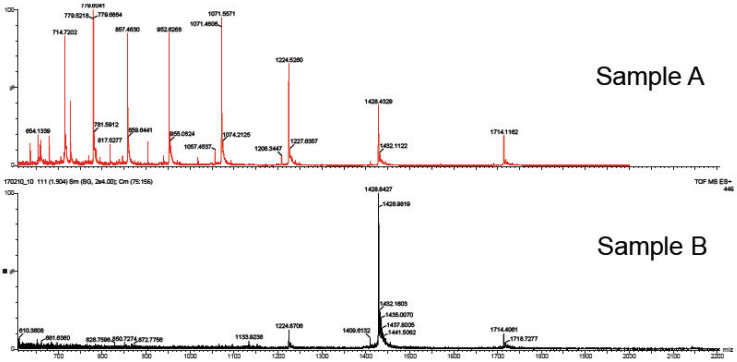
QUIZ 1 – REAL WORLD EXAMPLE



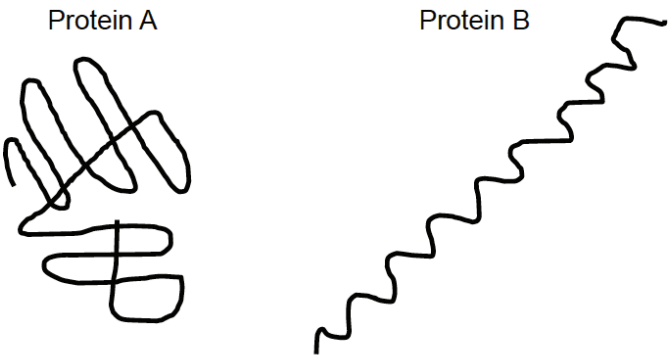
Ubiquitin (76 res)

ESI mass spectra of the protein Ubiquitin from two different samples.

Q: Which sample contains Ubiquitin in its a) folded state and b) unfolded state

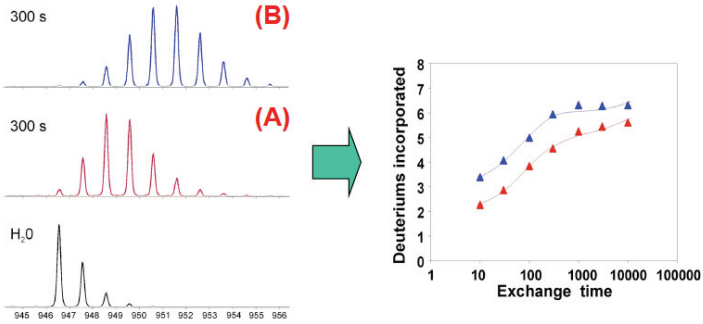


QUIZ 2 – Protein ion mobility?



Q: Which protein has the highest ion mobility?

Peptides used to monitor H/D exchange of the protease domain of FVIIa: (QUIZ 3)



Q: Which mass spectrum (A) or (B) corresponds to a peptide of FVIIa after the FVIIa protein has undergone H/D exchange (300s) while bound to its cofactor protein Tissue Factor (TF).

B Questionnaire

Dear attendees at the PhD course in Mass Spectrometry Coupled to Separation Techniques in Bioanalytical Chemistry

In light of your recent completion of the PhD course, I am now conducting an evaluation of parts of the course and it is very important that I receive some brief feedback from you.

You may recall that I gave the last two lectures on the last day of the course (Friday 20/1) concerning the topic Analysis of protein conformation by MS. Since then a week has passed. Presently, I am interested in evaluating (a) your opinion and (b) your learning from three quiz session in my lectures.

Please take 5 minutes to answer the questions below. Just press reply to this mail and type your answers directly after each question and send the mail back to me.

Use only your memory to answer the questions below and do not use the course material or anything else. Your answers will be used solely for internal evaluation purposes and nothing else and naturally will be fully confidential. To help you remember the actual quiz questions, I have attached the three slides that I used to present Quiz 1-3 during the lectures.

Question A: Do you remember the correct answers to Quiz 1? If so, what are they?

Question B: Do you remember the correct answer to Quiz 2? If so, what is it?

Question C: Do you remember the correct answer to Quiz 3? If so, what is it?

Question D: Did Quiz 1, Quiz 2 and Quiz 3 help you to improve your understanding of the main subjects covered in the two lectures?

Question E: Do you have any additional comments you would like to share?

Thanks in advance for your time, I greatly appreciate your feedback. If anything is not clear then feel free to contact me.

Kind regards,

Kasper D. Rand

C Answers to questions A-E

Question A: Do you remember the correct answers to Quiz 1? If so, what are they?

Yes, I remember the answers. Sample A = unfolded; many chargeable sites exposed. Sample B = folded, most chargeable sites are masked in the tertiary structure.

Question B: Do you remember the correct answer to Quiz 2? If so, what is it?

I am not sure that I remember the correct answer. I remember discussing this in a small group and I remember some of the arguments from when we discussed it with you in the large group. However, I do not remember for sure if these arguments were correct or incorrect. I think protein A has the highest ion mobility.

Question C: Do you remember the correct answer to Quiz 3? If so, what is it?

Yes, I remember the answers. Mass spectrum A corresponds to the protein bound to the cofactor. The binding results in less H/D exchange and accordingly the m/z values are lower than in spectrum B, where higher D content increases the m/z value.

Question D: Did Quiz 1, Quiz 2 and Quiz 3 help you to improve your understanding of the main subjects covered in the two lectures?

Yes, absolutely. It improved my concentration and interest in the topics that I actively had to apply the introduced concepts.

Question E: Do you have any additional comments you would like to share?

It is an ungrateful task to give the last lectures on Friday afternoon. Initially, my level of concentration was very low at this point of the course. It had been a long and interesting week with lots of learning and Friday afternoon my head felt full. Furthermore, I do not work with protein/peptide MS, nor do I plan to, so I do not have an inherent interest in the topic. In essence, my motivation for listening and learning was minimal. However, your lectures managed to capture my attention to much greater extend than I had expected. The quiz questions and the associated short group discus-

sions were important contributors to this.

However, the examples of biological applications towards the end of the lecture did not manage to keep my attention. So if you have to cut the lectures short, in my opinion, this last part is far less important and interesting than the quiz questions.

D Evaluation form

Evaluering af øvelse i massespektrometrisk analyse af et protein i forskellige farmaceutiske formuleringer:

1. Havde du forberedt dig til denne øvelse? hvordan?

2. Var laboratorieøvelsen interessant? Hvorfor/hvorfor ikke?

3. Har denne øvelse givet dig lyst til at lære mere omkring proteiner og deres rolle som lægemidler?

4. Syntes du at du lærte noget som var relevant for dit a) bachelorprojekt i farmaci og b) din videre uddannelse på FARMA

5. Adskiller denne laboratorieøvelse sig fra andet laboratoriearbejde du har foretaget dig i løbet af din uddannelse på FARMA indtil nu? Hvis ja, hvordan?

6. Havde du væsentlige forståelsesmæssige spørgsmål som du ikke fik afklaret under øvelsen?

7. Var der rigeligt tid sat af til at du kunne stille spørgsmål?

8. Har du andre kommentarer til denne laboratorieøvelse?

9. Har du andre kommentarer til min undervisning omkring denne øvelse?

11

Evaluating the impact on student activity and level of deep learning when implementing problem-oriented student activities in a lecture

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Introduction

Several studies indicate that traditional models of learning based on memorizing and reproducing knowledge on demand do not develop reasoning skills, flexible knowledge or the ability to apply knowledge, to reflect and solve problems in new contexts. In order to do so, the students need to be actively engaged while learning, which leads to higher levels of performance, intrinsic motivation and productivity. Problem-based learning (PBL) is an example of an active teaching method in which the students develop self-directed learning, effective problem solving and decision making skills and thereby become progressively deeper in their approaches to learning compared with traditionally taught students (Newble & Clarke 1986, Hmelo-Silver 2004). Obtaining a deeper understanding of the subject as well as realizing how different threads of a subject are related to one another will also provide a better long-term recall of the knowledge the students acquire.

Particularly, the traditional lecture is an example of passive teaching in which the students typically remain inactive during a teacher-based monologue, thereby promoting a surface approach to learning. As lectures are often the dominant way of teaching at universities, reflections concerning how to activate students towards a deeper learning approach become essential (Gibbs 1981). Implementing a PBL-like approach using dialogue, asking questions, handing out small assignments for group work may promote an increased level of activity among the students, make them reflect and let them know of both the limitations and applications of the obtained

knowledge in specific case stories or problems thereby leading to a deeper learning approach.

However, several problems concerning both planning, executing and evaluating this type of deep learning approach may arise when introduced in one's own teaching. PBL is very sensitive to context and climate (Biggs & Tang 2007). First, the teacher is required to adopt a different philosophy of professional education; that education is more than acquisition of separate bodies of knowledge, and that both content and amount of teaching material for the lectures needs to be adjusted and restricted for this type of learning approach. Implementing either exercises for the students that reinforce and apply what has already been taught or designing problems set before the relevant knowledge has been acquired both represent a demanding and somewhat time-consuming task that may require severe adjustments of the current curriculum. Second, the teacher is required to be flexible, and planning the lecture should make room for both expected and unexpected dialogue and discussions in which the students are greatly involved. Finally, it takes some effort to create an appropriate atmosphere to motivate the students to be actively engaged which is a prerequisite for this type of learning approach.

Aim

The aim of this study is to change one's current teaching and develop quality enhancement processes and strategies focusing on what problem-based learning (PBL) ideas and techniques to implement in a lecture based teaching for improving the level of student activity and engagement as well as increasing the outcome of deeper learning.

Methods

The setup for implementing a PBL-like technique with increased focus on dialogue, discussions and actively solving problems was based on two specific lectures on bacterial whole-cell biosensors as well as on design and applications of microarrays, respectively. Both are part of the course "Emerging Techniques in Molecular Microbiology" at master level. The course usually hosts 20-25 students and teaching is a mixture of practical exercises, student presentations and lectures performed in English in the same

classroom. Previously, the lectures were focused on giving the students a basic introduction to the techniques and applications within the above mentioned research fields, and the students were expected only to reproduce and memorize these pieces of information promoting a passive, and according to theory, surface learning approach.

In order to increase the taxonomical level of the learning outcome towards a deeper understanding, pedagogical considerations have been made concerning what changes to make for employing a PBL-like method that adapts student activities ranging from engagement in classroom discussions to single or group based exercises. Enhancing the intrinsic motivation of students is a major advantage in PBL (Hmelo-Silver 2004). Consequently, designing a lecture that implements questions, assignments, discussions and variation for sustaining a high level of activity seems essential but will also require careful planning and selection of the content of material to be taught in order to make room for the intended activities.

In traditional PBL problems are usually set before the knowledge has been acquired, forcing students to acquire the knowledge they need before solving the task (Biggs & Tang 2007). For these lectures a slightly different format was used in which exercises and questions were designed to reinforce what has already been taught and demonstrate the relevance and use of knowledge already acquired. The following techniques were applied; specify the learning objectives as soon as possible, introduce an unsolved, but relevant case as an appetizer, use examples from real life to illustrate applications in order to make the students relate to the topic and during the lecture combine this knowledge with acquired blocks of factual information regarding design and techniques. The idea is to engage a motivation for the students to construct knowledge and enable them to solve assignments based on applying, analyzing and designing. Such assignments are handed out as group work (as part of the previously introduced case) and will be discussed in plenum in order to create dialogue and reflection. Additionally, questions, some having specific answers, others open for dialogue and discussion, will be given during the lecture to further actively engage the students. Finally, the lectures will be paused a couple of times in order to summarize the content on the blackboard, leaving time for the students to further reflect, structure and ask clarifying questions.

However, in order to develop and improve one's teaching further it is essential to produce an evaluation that provides information regarding impact level, level of activity as well as extent of learning outcome. Specifically, the following questions need answers:

- Are students motivated and activated to a higher degree when implementing class discussions, asking questions during the lecture, handing out small group exercises and structuring the lecture by summarizing on the blackboard for further reflection?
- Do the students appreciate this type of lecture and do they feel that they learn more efficiently and to a deeper extent?

For assessing the first lecture on biosensors, the students responded to a questionnaire (Appendix A) provided the same day. The questions raised were divided into sections, among them a general part addressing the alignment of learning objectives and the content of the lecture, whereas other sections of the questionnaire were focused on evaluating the impact on student activity and learning outcome of using either the black-board for summarizing and structuring, asking the class questions for obtaining dialogue or handing out small group exercises for plenary discussions. Specific academic questions directly testing the outcome of deeper learning could have been implemented but, to avoiding a too comprehensive questionnaire, the students were asked how they felt about their deeper learning as well as what concepts from the lecture they regard as the most important.

The second lecture regarding microarray design was assessed using the Delphi method best described as an anonymous group communication process in which a consensus of specific opinions is developed (Hsu & Sandford 2007). This type of feedback process is not as controlled as the questionnaire, but operates more openly, allowing the evaluators to express individual and qualitative observations that subsequently are quantified by others rating the statements as either agree or disagree. The Delphi evaluation was meant to supplement the questionnaire despite not assessing the same lecture. This might be a drawback, yet minimized by the fact that both lectures were planned and structured in the same way.

Results

For the evaluation of the biosensor lecture, eighteen students out of twenty answered the questionnaire, which indicates a good representation for statistical analysis. All data from this evaluation are listed in Appendix B, including the results from each individual evaluator.

Most students agreed on the fact that the learning objectives, presented in the beginning of the lecture, clearly stated what they were supposed to

learn and subsequently guided the teaching in a purposeful way (Fig. 11.1). For the outcome of each specific learning objective, the standard deviations become somewhat higher, but respondents tend to gain high outcomes for all objectives. There is a slight tendency indicating the lowest outcome on the objective that illustrates learning at a taxonomical deeper level of understanding (Construct, design and analyze your own whole-cell bacterial biosensor). Otherwise the scores do not seem to be significantly different (Fig. 11.1).

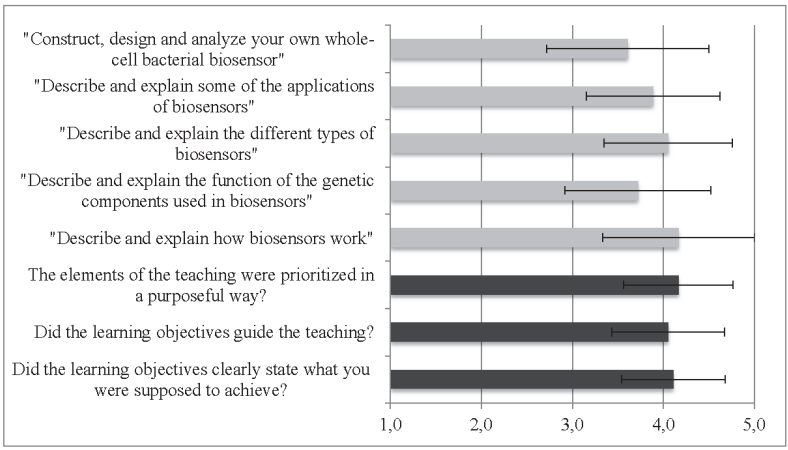

Fig. 11.1. Evaluation of the learning objectives of the biosensor lecture (dark grey) as well as the learning outcome from each individual learning objective (light grey). The outcome of each objective was evaluated on a scale from 1 to 5, 1 being the lowest and 5 the highest. The opinion of the learning objectives in general was rated 1: Fully disagree to 5: Fully agree. The black, horizontal bars indicate the standard deviations of the data.

When looking into statements on what people found particularly important during the lecture, categorizing these as either surface learning or deeper learning, indicates that the distribution is quite equal with almost the same amount of votes for both categories (Fig. 11.2). These findings more or less support the data in figure 11.1 and illustrates that the students have gained knowledge from all learning objectives (as listed in figure 11.1), leaning slightly more towards basic knowledge.

Statements	Number of "votes"
How biosensors work (S)	6
Different types of biosensors (S)	8
Reporter genes (S)	6
Applications of biosensors (S/D)	8
Many parameters (promoter, reporter, specificity, sensitivity, basal levels) to account for (D)	7
How to construct biosensors (D)	6

Fig. 11.2. An overview of statements written by the students to describe what they found most important during the lecture. The statements have been categorized with S: Surface learning or D: Deep learning, according to the taxonomical level of the statement.

In general, the students seem satisfied with this type and structure of teaching as the general learning outcome of the lecture has been rated quite high (good or very good) with a small standard deviation (Fig. 11.2). The general outcome of discussions, questions and the group exercise has also on average been rated as good, but the standard deviations tend to increase, indicating some outliers that obviously prefer a traditional lecture compared to the PBL activities (Fig. 11.3). This is supported by the fact that exactly the same people who dislike PBL activities tend to rate the lecture as the best method for obtaining a deeper understanding (data for individual evaluators are stated in Appendix B).

Concerning the impact of questions, discussions and group exercise on the level of activity and deeper learning, the respondents agree on some positive effect. However, the standard deviations are quite high, supporting the fact that some people prefer traditional lectures over PBL activities.

Interestingly, the impact of PBL activities on level of student activity and engagement is only slightly above average (Fig. 11.3), but studying the individual evaluations (Appendix B) reveals that those who do not show an increased level of activity still seem to obtain an increased level of understanding, which is also reflected in the level of knowledge gained by the specific people at learning objectives representing design and construction issues.

When looking into the specific evaluations on use of blackboard, asking the class questions, and having the group exercise, this tendency is repeated (Fig. 11.3). Neither the group exercise nor asking the class questions is found to increase the level of participation and activity much.

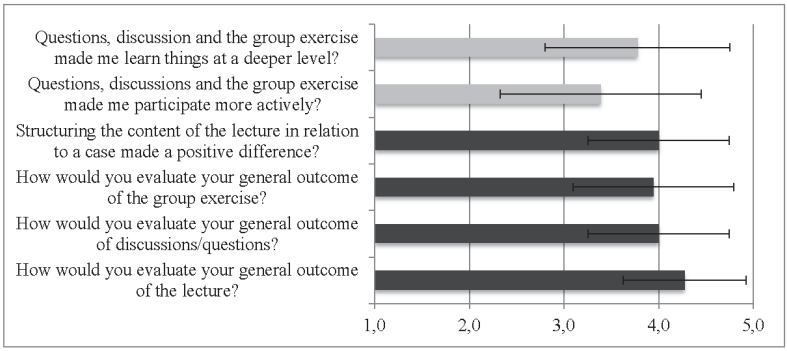

Fig. 11.3. General outcome from lecture, discussions, questions and group exercise; lower bars (dark grey) ranking from 1: very bad to 5: very good. Impact of discussions, questions and group exercise on activity level and level of deeper learning; upper bars (light grey) ranking from 1: fully disagree to 5: fully agree. The black, horizontal bars indicate the standard deviations of the data.

Despite huge standard deviations, the average of these statements is just a bit above neutral. However, students seem to agree that the group exercise helps to clarify important concepts and increases the level of higher understanding, whereas asking questions is relevant according to the learning objectives (Fig. 11.4). The huge standard deviations observed for statements regarding activity level illustrate that some people (around five in this investigation) tend to gain a high learning outcome without necessarily feeling actively engaged (individual data in Appendix B). Usually, one would expect these parameters to be more closely related; activity and engagement stimulating a deeper approach to learning. In general, this also goes for most respondents in this sample.

Using the blackboard for summarizing key points from the lecture seems on average to have a positive impact regarding giving the students time for reflection and asking questions to clarify unclear concepts. Even when taking the rather huge standard deviations into consideration the positive feeling about the blackboard never goes below neutral (Fig. 11.4). A few people seem to dislike the blackboard, but in general neither asking questions nor using the blackboard is stated as being disturbing to the lecture (Fig. 11.4).

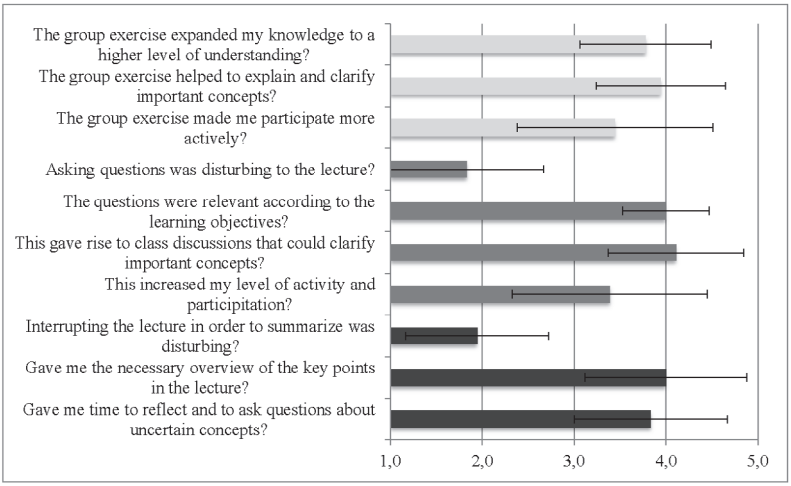

Fig. 11.4. Specific evaluations on: 1. Group exercise (light grey); 2. Asking questions (medium grey); 3. Using the blackboard for keynotes (dark grey). All statements are ranked from 1 (fully disagree) to 5 (fully agree). Some statements are left out, but data can be found in Appendix B. The black, horizontal bars indicate standard deviations.

When quantifying the contribution of lecture, blackboard, questions and group exercise, respectively, on outcome of surface learning, deeper learning or level of activity, using the blackboard does not get high scores but tends to account for around 10 % in all cases (Fig. 11.5). In general, the disagreement among the evaluators in finding some consensus is high, as indicated by huge standard deviations. In general, the lecture dominates in stimulating surface- and deeper learning, whereas the group exercise gets a slightly higher score for stimulating the level of activity. On the other hand, people agree that the group exercise does not contribute much in stimulating surface learning. Asking the class questions seems to account for 20-25 % in all categories.

Evaluating personal comments on issues that people particularly liked supports previous findings stating the group exercise and blackboard notes as positive elements (Fig. 11.6). Additionally, the structure and slides of the lecture as well as the engagement of the teacher was emphasized. Comparing these individual comments to the findings from the Delphi method

	Lecture	Blackboard	Questions	Group exercise
Outcome of surface learning	**51.5** ± 26.2	14.1 ± 22.6	21.1 ± 22	13.4 ± 10.3
Outcome of deeper learning	**42.9** ± 27.1	12.1 ± 23.6	22.1 ± 21.8	22.9 ± 18.6
Level of activity	29.5 ± 31.3	12.1 ± 23.6	23.1 ± 20.9	**35.4** ± 33.2

Fig. 11.5. Contribution of Lecture and PBL-like activities on the outcome of surface learning or deeper learning as well as on the level of activity and engagement. Numbers are given in percentage. Standard deviations are indicated.

(complete dataset in Appendix C) indicates that people have focused on the same issues in both lectures (Fig. 11.6).

Questionnaire		**Delphi**	
What people liked	**Vote**	**Statement**	**Agree/Disagree**
Slides	6	Too much repetition, could have used less explanation time	6/7
Structure of lecture	7	Very informative lecture	12/1
Engagement of teacher	6	Discussions and summaries of exercises were awesome	10/3
Questions asked to the students	3	Time for questions and discussion is a plus	12/1
Blackboard notes	6	Keynotes on blackboard are good	9/4
Group exercise	6	Good to have student exercises	12/1
		Blackboard notes did not add anything important	5/8

Fig. 11.6. Summary of individual statements of issues from the biosensor lecture that people liked (left column). These are quantified by the number of people agreeing on these (votes). Summary of individual statements from the Delphi method (right column). Delphi statements are quantified by the number of people agreeing or disagreeing with the given statement. For the Delphi method, 13 of 18 students did the evaluation.

The Delphi evaluation reveals that the students agreed on liking the lecture and found that student exercises and summaries of these as well as discussions and time for questions were a plus. Again, using the blackboard for summarizing keynotes is an issue that received favourable comments that some people tend to like very much, whereas others find this quite disturbing. Specifically, not using the blackboard was listed by three students as a

suggestion for improvement in the questionnaire (Appendix B). However, as seen previously, most people agree that using the blackboard is positive.

Other suggestions for improvement include putting the answers from the exercises on the blackboard, asking harder questions, using more examples of applications and making the slides available before the lecture.

Discussion

The student evaluations indicated that the applied PBL teaching activities such as summarizing keynotes on the blackboard, asking the students questions during the lecture and having small group exercises could to some extent motivate and activate most students to reflect on the course content and experience an increased- and somewhat deeper learning outcome. However, there was some disagreement concerning the impact of the implemented tools on the level of engagement, and clearly a few students did not experience an increased level of activity and motivation, despite indicating an improved learning outcome. The self-evaluation, based on perception of teaching experience, indicated that the changes implemented did sustain a higher level of student activity. In general, 50-60 % of the students were actively engaged and focused and clearly participated in the plenum discussions compared with traditional lectures in which I mostly do all the talking, while the students remain passively listening. Clearly, dialogue seemed to create an open atmosphere and helped to create an interactive classroom. These observations are in agreement with other studies showing that students gain a higher level of understanding when relevantly active and motivated with learning activities that require them to reflect and think about novel problems and apply the knowledge they have gained (Mazur 1998, Hmelo-Silver 2004).

In general, all PBL activities seemed to be successful in contributing to the observed improvements. Something to consider particularly successful, and which was also pointed out in the comments of several evaluators, was using the blackboard for summarizing keynotes. This may seem interrupting to the lecture, also from a teacher's point of view, and clearly some students dislike this activity, but to most students summarizing important concepts or answers from exercises was indeed a positive experience that gave them time to reflect and ask questions about unclear concepts. Usually, reflection helps students to relate their new knowledge to their prior understanding and to understand how their problem-solving strategies might

be reapplied. Reflection makes students tie general concepts and skills together, constructing a more coherent understanding (Chi et al. 1989). According to theory, using the blackboard should indeed be essential in making the students reflect on their knowledge and strategies relative to a problem, which is a prerequisite for deeper learning.

The group exercise was stated as another positive issue relevant for expanding student knowledge and for explaining unclear connections. For most students the exercises increased the level of activity, whereas a few students did not feel more engaged, but yet could gain a deeper approach to learning anyway. Self-evaluation also indicated that students were focused and concentrated on the exercises and many students took an active part in subsequent plenary discussions. Consequently, using small group exercises seems essential when implementing PBL activities. This is supported by the fact that problem solving is a way to achieve a self-defined learning goal and that the relationship between problem solving and learning is a critical component of PBL and is required to support the construction of extensive and flexible knowledge (Salomon & Perkins 1989).

However, various factors can influence the implementation of PBL activities: the extent of incorporation of PBL into the curriculum, group dynamics, nature of problems used and the motivation of the learners. Second, structuring and planning a lecture that contains a variable amount of learning activities is both time consuming and challenging. The number of PowerPoint slides must be kept to a minimum so that only the essential parts of the curriculum can be presented. This requires a certain focus and prioritizing of the teacher. From self-evaluation it became clear though, that despite thoroughly planning the lecture, the outcome might be different as control is hard to maintain when interaction and dialogue is expected.

Practising and further improving this type of teaching in future lectures seems essential for increasing the learning outcome. Based on this study, several points need to be taken into consideration; It was pointed out that people need a small break during the lecture which supports other findings stating that a short rest, or change in activity, every fifteen minutes restores performance to almost original level (Biggs & Tang 2007). Second, group exercises can be improved by introducing these properly and writing the proposed answers on the blackboard. Finally, when asking questions during the lecture, these should be thoroughly prepared and made relevant according to learning objectives. Some suggested that the questions could perhaps be harder, which would require more time for the students to think, perhaps accompanied by their neighbours.

Conclusion

In general, the employed changes and tools of PBL-like activities seemed to have improved teaching performance leading to an increased level of learning outcome. For most students learning activities such as using the blackboard for summarizing keynotes, asking the students questions and handing out exercises also seemed to increase the level of activity and engagement. Only a few students claimed not to have been engaged by these learning activities, but yet even they seem to have obtained an improved level of learning outcome. Self-evaluation also indicated an increased interaction with the students and most students seemed active and engaged compared with traditional lectures based on monologue and passive listening.

A Evaluation of Biosensor lecture 8 May 2012

General:

How would you evaluate your general outcome of the lecture?

Very good Good Neutral Bad Very bad

How would you evaluate your general outcome of the discussions/questions in the class during the lecture?

Very good Good Neutral Bad Very bad

How would you evaluate your general outcome of the group exercise?

Very good Good Neutral Bad Very bad

The "Learning objectives", which were first provided in the lecture, clearly stated what you were supposed to achieve?

Agree fully Agree Neutral Disagree Disagree fully

The "Learning objectives" guided the teaching?

Agree fully Agree Neutral Disagree Disagree fully

The elements of the teaching were prioritized in a purposeful way in the light of the "Learning objectives"?

Agree fully Agree Neutral Disagree Disagree fully

How well have you learned what the following "Learning objectives" of the day stated on a scale from 1 to 5 (1 lowest, 5 highest)?

1. Describe and explain how biosensors work
   1 2 3 4 5
2. Describe and explain the function of the genetic components used in the construction of biosensors
   1 2 3 4 5
3. Describe and explain the different types of biosensors
   1 2 3 4 5
4. Describe and explain some of the applications of biosensors
   1 2 3 4 5

5. Construct, design and analyze your own whole-cell bacterial biosensor
   1 2 3 4 5

Structuring the content of the lecture in relation to a case/problem has made a positive difference compared to an ordinary lecture?

Agree fully Agree Neutral Disagree Disagree fully

Introducing an actual case/problem in the beginning of the lecture had a positive effect on my motivation and level of engagement?

Agree fully Agree Neutral Disagree Disagree fully

The content of the lecture based on questions, discussions and the group exercise made me participate more actively than during an ordinary lecture?

Agree fully Agree Neutral Disagree Disagree fully

The content of the lecture based on questions, discussions and the group exercise made me learn things at a deeper level of understanding (design, construct, analyze)?

Agree fully Agree Neutral Disagree Disagree fully

Please state the distribution of your outcome of surface learning (ability to explain and describe concepts) between the different parts of the lecture (in percentage summing up to 100%):

Lecture Blackboard Questions/discussions Group exercise

Please state the distribution of your outcome of deeper learning (ability to analyze, design, construct, evaluate) between the different parts of the lecture (in percentage summing up to 100%):

Lecture Blackboard Questions/discussions Group exercise

Please state the distribution of your level of activity and participation between the different parts of the lecture (in percentage summing up to 100%):

Lecture Blackboard Questions/discussions Group exercise

Use of Blackboard to summarize/repeat important concepts:

This gave me time to reflect and to ask questions about unclear connections?

Agree fully Agree Neutral Disagree Disagree fully

This gave me the necessary overview of the key points of the lecture?

Agree fully Agree Neutral Disagree Disagree fully

Interrupting the lecture in order to summarize important points was quite disturbing?

Agree fully Agree Neutral Disagree Disagree fully

Asking students questions during the lecture:

Asking questions to the class helped me to keep concentrated and focused on the lecture?

Agree fully Agree Neutral Disagree Disagree fully

Asking questions to the class increased my level of activity and participation during the lecture?

Agree fully Agree Neutral Disagree Disagree fully

Asking questions gave rise to class discussions that could help clarify/understand important concepts?

Agree fully Agree Neutral Disagree Disagree fully

The amount of questions asked was too high?

Agree fully Agree Neutral Disagree Disagree fully

The questions asked were relevant according to the “Learning objectives”?

Agree fully Agree Neutral Disagree Disagree fully

The questions asked were well balanced and neither too hard nor too easy to answer?

Agree fully Agree Neutral Disagree Disagree fully

Asking questions to the class was disturbing to the lecture?

Agree fully Agree Neutral Disagree Disagree fully

Small group exercise:

The group exercise increased my motivation for the subject?

Agree fully Agree Neutral Disagree Disagree fully

The group exercise made me participate more actively in the final class discussion?

Agree fully Agree Neutral Disagree Disagree fully

The group exercise helped to explain and clarify important concepts?

Agree fully Agree Neutral Disagree Disagree fully

The group exercise expanded my basic knowledge obtained during the lecture to a higher level of understanding at which I could partly design, construct, evaluate and analyze biosensor related topics/problems?

Agree fully Agree Neutral Disagree Disagree fully

List the 3 most important things/concepts from today's lecture (that you find important):

1.

2.

3.

List 3 things that you like in particular about today's lecture:

List 3 suggestions for improvements:

B Results from student evaluation based on questionnaire

Statement	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	Mean	STD Dev
General (Very good: 5, Very bad: 1 or Agree fully: 5, Disagree fully: 1)																				
How would you evaluate your general outcome of the lecture?	5	5	4	5	4	4	4	4	5	5	5	5	4	3	4	4	4	3	4.3	0.65
How would you evaluate your general outcome of discussions/questions?	5	4	4	5	4	5	3	4	4	4	5	4	4	3	4	4	4	2	4.0	0.75
How would you evaluate your general outcome of the group exercise?	3	4	4	5	4	5	3	4	3	5	4	5	3	2	5	4	4	4	3.9	0.85
Structuring the content of the lecture in relation to a case/problem has made a positive difference?	5	4	4	4	4	4	3	4	4	5	4	5	4	3	5	4	4	2	4.0	0.75
Introducing an actual case/problem in the beginning has a positive effect on motivation and engagement?	3	3	4	4	2	3	4	5	4	4	4	5	3	1	3	5	3	3	3.5	1.01
Questions, discussions and the group exercise made me participate more actively?	4	3	4	4	2	5	2	2	3	3	5	4	2	2	4	5	4	3	3.4	1.06
Questions, discussion and the group exercise made me learn things at a deeper level?	5	4	4	4	3	4	4	3	3	5	4	5	3	1	4	5	4	3	3.8	0.97
Learning objectives (Agree fully: 5, Disagree fully: 1)																				
Did the learning objectives clearly state what you were supposed to achieve?	4	4	4	4	3	4	4	4	4	4	5	4	5	4	5	5	4	3	4.1	0.57
Did the learning objectives guide the teaching?	5	4	4	3	3	4	4	4	4	5	4	5	4	4	4	5	4	3	4.1	0.62
The elements of the teaching were prioritized in a purposeful way in the light of the learning objectives?	5	4	4	4	4	4	4	4	3	4	5	4	4	4	5	5	5	3	4.2	0.60
How well have you learned the following learning objectives? (1 lowest, 5 highest)																				
"Describe and explain how biosensors work"	4	5	5	4	4	4	3	4	4	5	5	5	5	3	5	4	4	2	4.2	0.83
"Describe and explain the function of the genetic components used in construction of biosensors"	4	4	5	5	3	4	3	4	2	3	4	5	4	3	4	4	3	3	3.7	0.80
"Describe and explain the different types of biosensors"	3	4	5	4	4	5	3	3	4	5	5	4	4	3	5	4	4	4	4.1	0.70
"Describe and explain some of the applications of biosensors"	4	3	4	3	5	4	3	4	4	5	5	4	4	4	4	4	4	2	3.9	0.74
"Construct, design and analyze your own whole-cell bacterial biosensor"	4	3	5	4	4	5	3	4	2	4	4	4	3	2	5	3	3	3	3.6	0.89
Use of blackboard (Agree fully: 5, Disagree fully: 1)																				
Gave me time to reflect and to ask questions about uncertain connections?	4	5	4	4	4	3	4	3	5	4	4	4	4	2	4	5	2	4	3.8	0.83
Gave me the necessary overview of the key points in the lecture?	4	5	4	3	4	3	5	3	5	5	4	5	4	2	4	5	3	4	4.0	0.88
Interrupting the lecture in order to summarize was disturbing?	1	2	2	3	1	3	2	3	2	1	3	1	2	1	2	1	2	3	1.9	0.78
Asking questions during the lecture (Agree fully: 5, Disagree fully: 1)																				
This helped me to keep concentrated and focused?	5	3	4	5	4	5	4	3	4	5	4	4	2	3	4	4	5	2	3.9	0.94
This increased my level of activity and participation?	5	3	4	4	3	5	4	2	4	4	3	3	2	2	4	4	4	1	3.4	1.06

This gave rise to class discussions that could clarify important concepts?	5	4	4	4	5	5	4	4	4	5	4	4	4	3	4	5	4	2	4.1	0.74
The amount of questions was too high?	1	3	2	3	2	2	1	2	3	3	3	3	2	4	2	1	2	5	2.4	1.01
The questions were relevant according to the learning objectives?	5	4	4	4	4	4	4	3	4	5	4	4	4	4	4	4	4	3	4.0	0.47
The questions were balanced and neither too hard nor too easy?	5	4	4	4	4	4	4	4	3	4	5	4	4	2	4	4	3	2	3.8	0.79
Asking questions was disturbing to the lecture?	1	2	2	3	1	2	1	3	2	2	2	1	2	1	2	1	1	4	1.8	0.83
Small group exercise (Agree fully: 5, Disagree fully: 1)																				
The group exercise increased my motivation for the subject?	4	3	4	4	4	4	4	4	3	3	3	5	2	2	4	5	3	3	3.6	0.83
The group exercise made me participate more actively?	4	3	4	4	2	4	2	2	2	5	5	3	2	4	4	5	4	3	3.4	1.07
The group exercise helped to explain and clarify important concepts?	4	4	4	5	5	4	4	4	3	4	4	5	4	2	4	4	4	3	3.9	0.70
The group exercise expanded my knowledge to a higher level of understanding at which I could design, construct and analyze biosensors?	4	3	4	4	4	3	4	4	3	4	4	5	4	2	5	4	4	3	3.8	0.71
Distribution of outcome of surface learning (%)																				
Lecture	40	60	25	30	50	0		60	0	60	60	55	75	90	70	50	50	100	**51.5**	26.16
Blackboard	20	15	25	5	10	0		5	100	5	5	10	5	5	10	20	0	0	14.1	22.64
Questions/discussions	30	20	25	30	20	100		5	0	20	20	15	10	3	10	20	30	0	21.1	22.02
Group exercise	10	5	25	35	20	0		30	0	15	15	20	10	2	10	10	20	0	13.4	10.28
Distribution of outcome of deeper learning (%)																				
Lecture	40	50	25	20	50	0		40	0	40	50	65	75	90	30	20	35	100	**42.9**	27.07
Blackboard	10	5	25	0	10	0		0	100	30	0	10	5	0	0	10	0	0	12.1	23.64
Questions/discussions	30	25	25	30	20	100		15	0	15	20	10	10	10	10	20	35	0	22.1	21.76
Group exercise	20	20	25	50	20	0		45	0	15	30	15	10	0	60	50	30	0	22.9	18.56
Distribution of outcome of level of activity (%)																				
Lecture	10	0	25	20	50	0		25	0	10	40	0	65	96	0	40	20	100	**29.5**	31.27
Blackboard	10	0	25	0	20	0		25	100	10	0	0	5	1	0	10	0	0	12.1	23.61
Questions/discussions	70	0	25	40	20	0		25	0	50	30	0	20	2	50	20	40	0	23.1	20.88
Group exercise	10	100	25	40	10	100		25	0	30	30	100	10	1	50	30	40	0	**35.4**	33.17
Typical what people find important (S: Surface learning, D: Deeper learning):																				
How biosensors work (S)		1	1	1					1			1	1						6	
Different types of biosensors (S)		1	1	1		1			1		1		1			1			8	
Reporter genes (S)		1	1		1		1								1	1			6	
Applications of biosensors (S/D)				1	1				1		1	1	1	1	1				8	
Many parameters (promoter, reporter, specificity, sensitivity, basal levels) in biosensing to account for (D)	1		1		1	1	1							1		1			7	
How to construct biosensors (D)									1		1	1		1	1	1			6	
Things people liked:																				
Blackboard notes	1	1			1					1			1			1			6	
Questions asked to the students	1			1													1		3	
Slides		1		1							1	1	1	1					6	
Motivation and engagement of the teacher			1		1						1	1	1				1		6	
Structure of the lecture			1							1		1	1	1		1	1		7	
Group exercise				1	1	1				1		1			1				6	
Suggestions for improvements:																				
Put answers for exercise on blackboard		1		1						1		1							4	
Ask harder questions			1																1	
Do not use the blackboard						1					1	1							3	
More examples on applications from real life									1										1	
Slides available before lecture													1						1	

C Results from student evaluation based on Delphi Method

Statements	Agree	Disagree	Blank
Slide pictures are too small	8	5	
Start the lecture introducing the applications	7	6	
Discussions and summaries of exercises were awesome	10	3	
The blackboard sessions didn't add anything important	5	8	
Good to have student exercises	12	1	
The lecture was too "pedagogical", could have used less explanation time	6	7	
Need 5 min break in the middle of the lecture	10	3	
Keynotes on blackboard are good	9	4	
Too much repetition compared to amount of information	6	7	
Good idea with keynotes on blackboard?	8	3	2
Time for questions and discussions is a plus	12	1	
Summarizing main points on blackboard is really good	9	3	1
Very informative lecture	12	0	1

12

The evaluation of different teaching styles and level partitioning teaching on the Bioinformatics of High Throughput Analysis course

Jette Bornholdt Lange and Mette Boyd

Institute of Biology, SCIENCE, University of Copenhagen

Introduction

During our course Introduction to University Pedagogy, we have been presented to different ways of performing active based learning in order to obtain a higher level of deep learning for the students. In order to test the implementation of different student activities, we have decided to implement three main types of teaching styles on the course Bioinformatics of High Throughput Analysis (BOHTA) for bioinformatics and biomedicine students. The three different teaching styles will be tried on three different course days. On day one of the teaching, we have planned to do short (fifteen minutes) lectures in a combination with small five minute Teaching and Learning Activities (TLAs). Day two will start with a thirty-minute introduction to the theoretical topic followed by the students working in groups on a case-like problem. Finally, on day three the students will work in groups on a case and prepare a presentation of their work followed by a presentation in class.

The evaluation of the different teaching methods will be split into different categories. At first we would like to ask the students at the end of each session to describe how they experienced the teaching (including what they found the best or worst, how much work and energy it demanded and how much they think they learned from the session).

We will also try to evaluate the teaching by one of us monitoring the session and notice the amount of questions and the activity amongst the students during the session and try to evaluate the outcome of the teaching style based on the students' answers to questions.

It will also be interesting for us to evaluate how the different teaching forms worked for us as teachers, what did we feel the most comfortable with, what was maybe too routine, and was anything more challenging? (like letting go of the control).

Finally, we will try to evaluate the outcome of offering students level partitioning teaching, based on their requirements for more biology or computational learning. This will be based on the evaluation of assignments handed in during the course and the final grade obtained this year compared with the previous two years. Unfortunately, the evaluation of the effect of level partitioning will be done after we have handed in this assignment due to summer vacation.

Inspired by our own experience and the work of Mazur (1997, 2009) we would generally like to move away from the traditional information transfer model in the normal lecture format and increase the focus on activating the students and try to improve their deep learning. One way of achieving this could be through group work, where the students are encouraged to go through the material covered in the previous lectures and explain this to the other group members. This of course requires that the students have paid attention during the lectures and are not afraid to share their knowledge.

Course description

The BOHTA course is mainly for students in the Molecular biomedicine or Bioinformatics study programme. The purpose of the course is to give the students tools for computational analysis of large biological datasets. This includes understanding the biology and laboratory techniques used to obtain the datasets as well as understanding the statistical and informatics techniques used for analysis of the data (Appendix A).

In previous years the students from Bioinformatics have requested a better introduction to the biology behind the large datasets instead of using a lot of time on basic programming in R. Given the very different requirements from the students, the course responsible decided this year to try and split the students for the first four sessions (each session being three times fifty minutes). The students with a biological background could choose four sessions with introduction to programming in R. Then the people with sufficient programming skills could choose to attend one session with a very short introduction to R followed by three sessions of introduction to the biology behind the datasets.

We have a strong biology background and experience in using these experimental techniques and were therefore asked to be responsible for teaching the three sessions with focus on some basic biology and the experimental techniques needed to understand the nature of the large biological datasets that they will need to work with later in the course.

Session 1

We first tried with the most standard way of teaching on this course. We have previously tried to stand and lecture for fortyfive minutes straight and were not interested in trying this again based on previous experience with a decline in concentration from everybody during these forty-five minutes (see Fig. 12.1).

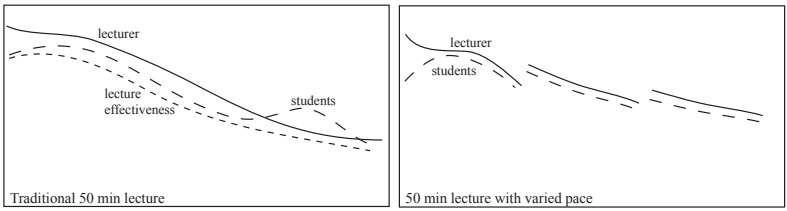

Fig. 12.1. The decline in student attention and lecturer performance from the start to the end of a traditional fifty-minute lecture. A rest, questions or simple exercises that varies the pace may produce the desired result. Based on Bligh (1998) after Lloyd (1968).

We decided to try with several short (10-15 minutes) lectures using PowerPoint slides and writing on the board. Each short lecture was followed by five minutes of exercises in groups of two.

Evaluation from the students on session 1

At the end of each of these three sessions we had set aside five minutes where we handed out an evaluation form to the students and asked them to fill these in.

The overall comments from the students were positive about the structure of the session. When asked if the exercises increased the learning outcome relative to time consumption most of the students without a biological background felt it was useful for understanding the theory better:

> "..., it was a 'plus' in the course structure, I understand better the theory."
> "yes, the practice helped a lot"
> "yes, I think that the exercises were entertaining"
> Also the students with biology background had an overall positive attitude towards the exercises.
> "good for visualization, but not really necessary"
> "yes, especially if the concepts seemed to abstract"

However, also a more negative comment was returned: "Perhaps slightly less time could be spent on exercises if exercises were done individually, less time would be used."

Observation of students during session 1

A couple of students were surfing the Internet and were only participating during the exercises. We later found out that these students all had a biology background. A small group of students with a non-biological background was very focused, but were lost during the heavy theory slides. However, they actively participated in the exercises. The rest of the students were paying attention and able to ask questions and participated in the exercises.

In conclusion, we had a very heterogeneous group of students in relation to the professional starting level. The course was aimed at students with a very limited biological understanding, next time we should make sure to eliminate the students with a strong biology background, since they made the non-biologists feel inferior and this can perhaps hold back some of their questions.

Our evaluation of session 1

The day after the session we sat down and discussed the experience of the teaching. We both agreed that the students seemed active during the session and participated in the exercises and came up with answers. But we both experienced a time pressure with too little time for both lecturing and exercises. In order to make five minutes for exercises we found that we had to compromise with the level and complexity of the exercises. It was also

difficult to make time to talk or help out all the groups, especially as we experience the importance of formulating a very precise five-minute exercise without making it just a pop-quiz repeating the material just taught.

We concluded that in future teaching situations small student activities could be helpful, but perhaps in a combination with questions of more clarifying character especially in smaller classes like ours.

Session 2

On the second day of this course the students would hopefully have the basic biological knowledge and we would like to increase the length of the group exercises in order to cover more advanced questions also using cases. The case study as a method pedagogically engages the students in analyzing, evaluating, conceptualizing and discussing applications (Kunselman & Johnson 2004). According to Holkeboer (cited in Kunselman & Johnson (2004)), it also makes the students develop a three-step critical-thinking process, where the students identify the core problem, brainstorm over possible solutions and find the best solution. The case exercise facilities critical thinking, which is one of the learning objectives for our students.

So on this day of teaching, we had two sessions (one each) where we lectured for approximately thirty minutes and then had time for thirty minutes of group work with a case based problem followed by a discussion. The exercises were problem solving, where the student had to use the techniques just lectured about.

Evaluation from the students on session 2

In the evaluation of the exercises relative to time consumption the answers vary somewhat. Some were positive:

> "Yes, the exercise was better today. They were less time consuming and actually raised some good questions."
> "Yes, I believe the exercises always help!"

However a large fraction of the students felt they had too much time to do the assignments:

> "yes, even though it was too much time given for them. It could have been a little bit shorter and maybe encourage more discussion"
> "it was good with teaching and exercise but the exercises were short in relation to the time"

Finally, a fraction of the students did not like the exercises.

"Not really. I don't think that's the best way for be to learn anyway."
"I think that the exercise today were not that helpful."

Observation of the students during session 2

During this session we had that same pattern of behavior from the students during the lecturing part, that some were surfing the net, others paying attention and asking questions and finally the students without any prior biological background struggling to keep up. During the exercises the students were allowed to form groups by themselves and administrate a break, resulting in some of them having very long breaks until the common round up. During the round up, it was mainly the students with a strong biology background that came with input and we as teachers ended up giving many of the answers.

Our evaluation of session 2

Discussing the teaching the next day we both had the feeling that 30 minute lectures seemed to function well for having time to introduce more advanced topics. The 30 minutes also provided us with enough time to ask or receive questions during the lectures from the students, making time for clarifying or repeating areas that can be difficult to comprehend. Our experience of the exercise was that it was not well enough structured to signal clearly what we expected them to do in the thirty-minute exercise. The purpose of the session should be stated more clearly at the beginning of the session. We also anticipated that the students were able to time-manage inserting a break in their group work, however this did not seem to be the case. Learning from experience the assignments given should be very well structured with direct questions to be answered and with sub-assignments to guide the students during their group work.

Session 3

This was the final day of teaching and inspired by the cooperative learning teaching method (described in Schmidt (2006)), we wanted the students to

try and work with the theory on their own in groups. Also they had to evaluate and give feedback to the other groups. As we previously experienced the importance of a thorough introduction, we started with five minutes introduction and then two hours of group work, while the session was finished with presentations by the students. This required the exercise to be quite structured so that the students knew what they were expected to do, since two hours is otherwise a very long time. Taught by experience we formed the groups in advance as well as administrating their breaks. We finished this session with the groups presenting their work in class and evaluating and discussing the presentations and results.

Evaluation from the students on session 3

At the end of each of these three sessions we had set aside five minutes where we handed out an evaluation form to the students and asked them to fill these in. The overall comments were generally positive:

> "Discussing is a very good way to learn and to practise"
> "And by commenting and summary in the end we learned many things."
> "Yes, the relaxed atmosphere led to interesting discussions."
> "It was interesting to have to actively think about those features instead of passively learn about them"

Some did not feel the content was challenging enough, however, they did not oppose the structure of the session.

Observation of the students during session 3

During the group work all the students participated in the internal discussions, of course some were more active than others. When going around between the three groups very different point of views and approaches could be observed. As this time we had made it clear to the students that all members of the group should present part of the work done by the group and that it was the responsibility of the group to make it possible, a lot of student teaching student took place. During the presentations all members of the groups showed an understanding of the subject. The rest of the students were asked to take notes for questions after having heard presentations from all three groups. In the final round up where the students should collect all the inputs presented by the three groups into one suggestion, the students were active, coming up with points to be included into the final product.

Our evaluation of session 3

In the evaluation of this session, we both felt that the session had gone well and that the atmosphere had been good with students participating actively. This time we had made the exercise more concrete, but still with open answers as the students had to design their own visualization tool, which could be done in a variety of ways. During the exercise there was enough time for the students to sit and discuss the different parts of the exercise as well as asking us questions, thus covering the theory presented in the previous two sessions. Both of us also felt that there was enough time to go around and help the groups. It seemed to work well that the students had to formulate and describe in their own words the biology we had tried to teach them. The group work gives us the opportunity to casually go and listen to the students discussing what they have understood and what needs to be clarified: this can be hard to achieve by making them ask questions in class. The more negative sides of this exercise was that it became a bit repetitive, but overall the exercise worked well to wrap up the short course, trying to collect the information given.

Student evaluation of the three types of teaching

In the evaluation only four students had attended all three sessions. Asked which form of teaching style they preferred the structure with lectures and the small exercises was the preference. However they also had comments like:

> "If the two forms (session 1 and 3) could be combined with a 70 % Tuesday (session 1) form and 30 % Monday (session 3) form, that would be best."

For session 3, none of the students prioritized it compared with the others, but the following sentences give indications of deeper learning:

Which one (session type) gave you the best understanding of the subject? Monday (session 3)

> "Difficult to say. At the last one (session 3) we discovered a couple of details, that I hadn't thought about before"

But as one of the students puts it:

> "I think that the proceeds of the teaching depends more on the given exercises and the group than the structure of the teaching. All three forms are good in their own way and to each thing."

Conclusion

This year's teaching was special in several ways, it was the first time the course was divided into a biology part and a programming part, so the students were not quite sure which part of the course they needed the most. We thus found that the students changed between the programming and the biology part during these four sessions, this is of course not the optimum situation when you are planning a continuous biology course, even as small as the one we did. We ended up having a mixture of biologists and bioinformaticians, which was never the purpose of this course. The choice for the students will hopefully be made clearer during the next years of teaching.

In addition to this we, as teachers, also wanted to use these three teaching sessions for this *Adjunktpædagogikum* assignment, thus placing greater demands on the teaching and evaluations. We strongly believe that the course content was not compromised by our additional demands, but that we as teachers were challenged to organize the material into the structure chosen for each of the sessions. In the future we do not have to try all the different lecturing formats but can choose the one we judge most appropriate at each session. We will most likely use a lecture-dominated first session and then shift towards more group work like we did this year. The advantage of activating the students during a session was quite clear to us and if these sessions remain a part of BOHTA, then the effort of making good TLAs is going to be a very good investment.

As mentioned before, this year was the first time the BOHTA course was divided into the first four sessions. Before planning the biology content and teaching style, we had a meeting with the course responsible in order to make sure that we covered the most essential topics of biology for the BOHTA course. We need more feedback from the students and the course-responsible in order to evaluate whether the focus of this years teaching was appropriate. If the students in the coming years are going to be divided more clearly based on their biology and programming background, we might have to change the course content to a lower level and cover a few more topics. The final decision of this will be taken, when we have the final evaluation of the students' overall performance in the course and the

final course evaluation by the students of BOHTA in general, to see if they think anything was lacking in the biology course that they needed later in the course.

We asked the students to fill in the evaluations after each session (see Appendix B) in order to get a better understanding of how the different teaching styles worked for the students learning outcome. The feedback from the students was of very mixed quality and we realize that we need to practise formulating the right kind of questions in order to get enough, relevant information from the students. We of course realize that not all students are going to bother with filling in such questionnaires no matter how much effort we put into it, but we did find that some of the students misunderstood the questions and thus answered with something completely beside the point. This year we had twelve students (at the most) and only four of them took part in all three sessions, so the evaluations are quite sporadic and the comparison of the three different teaching methods lack the significance that we had hoped for.

Some of the students were quite positive about the teaching formats and some were quite opposed to the exercises, this could of course reflect their different backgrounds or that they are more used to the conventional lecture format (Knight & Wood 2005).

In line with asking the right kind of questions, we also learned that we should ask very well structured questions, if we want to guide the students through a longer period of group work. This requires some additional practice in order to find the right balance between letting the students discuss freely in a group and having very structured questions.

In conclusion, this year's biology part of BOHTA was a successful experiment that has increased the biology knowledge of the students as well as giving the teachers some very useful insight into how the different teaching styles work in real situations. In addition, one of the key competences required of a bioinformatician is the ability to work well in groups with several different scientists; we therefore believe that the group work performed in these sessions is suitable to practise this. In addition it is important to learn how to communicate your knowledge both orally and in writing, which we have also tried to implement here. We therefore hope that our short course has done more than just give the students the required biology knowledge.

A Course information from sis.ku.dk – Bioinformatics of high throughput analyses

Udgave:	Forår 2012 NAT
Point:	7,5
Blokstruktur:	4. blok
Skemagruppe:	B
Institutter:	Bioinformatik-centret, Biologisk Institut
Uddannelsesdel:	Kandidat niveau
Kontaktpersoner:	Albin Sandelin albin@binf.ku.dk,
Skema- oplysninger:	Room allocation pending. As a rule, lectures/exercises Mondays 9.30-12, Tuesdays 13-16 and Fridays 9.30-12.
Skema- oplysninger:	Vis skema for kurset Samlet oversigt over tid og sted for alle kurser inden for Lektionsplan for Det Naturvidenskabelige Fakultet Forår 2012 NAT
Undervisnings-form:	Hybrid between lectures and computer exercises.
Formål:	After successfully completing the course, students will master the fundamentals of computational analysis of large biological datasets. This includes both i) understanding the diverse laboratory techniques and biological processes generating the data ii) understanding and mastering the statistical and informatics techniques used for analysis, including the selection of appropriate techniques for a given data and question and iii) interpreting analysis results in a biological context, and identify and apply follow-up analyses based on this. Special focus will be set on the following, both in teaching and evaluation: Extensive hands-on exercises to develop analysis skills; both within lessons and in home work. Analysis – and interpretation - of real biological data sets Realistic problem solving in which finding the exact methods - and the specific R syntax necessary - for attacking a question is an important part of the problem.
Indhold:	There are four major subject areas of the course: 1) Introduction to the program R and applied statistics, and data handling: This will be used throughout the course 2) Visualization, handling and analysis of genomic data using the genome browser, the galaxy tool and R 3) Expression analysis using microarrays and DNA sequencer data (”tag data”) using R and public tools 4) Analysis of proteomics data using R and public tools.
Målbeskrivelse:	To obtain the grade 12: The student must be able to explain the motivation, biological relevance and use of the methods covered in the course. The student must be able to understand and critically assess relevant scientific literature. The student must demonstrate expertise in the tools used in the course.

	The student must be able to suggest which methods and programs to apply for a given biological problem, and to point out problems and difficulties relating to such applications. Analogously, the student must be able to understand the strengths and weaknesses of different biological data types. The student must, with the help of program documentation and lecture material, be able to identify the methods that are appropriate and the syntax necessary for solving problems. The student must be able to after analysis interpret the analysis outcome in a biological setting, and identify and apply relevant follow up-analyses or extensions.
Lærebøger:	Scientific articles and handouts available on the home page (compulsory). We strongly recommend students to acquire ”Introductory Statistics with R” by Peter Dahlgaard (ISBN: 978-038795475)(free in the online university library), as it is a great help during and also after the course, but this is not compulsory.
Tilmelding:	Enrolment at Punkt KU from December 1 to December 10.
Faglige forudsætninger:	Students should have a molecular biology background corresponding to those of students in Bioinformatics or Biomedicine master programs (for instance "Introduction to Molecular Biology and Genetics" in block 1 or a life-science oriented bachelor education). Moreover, a basal statistics course such as "Statistics for Biomedicine" in block 2 is strongly recommended.
Eksamensform:	In order to be allowed to the final exam, the student must have had three smaller written group projects approved. The final exam is an individual larger written end-of-course homework. Students are given 1 week to finish it. 7-grade scale. Internal censor. Re-exam: Written homework as the ordinary exam. The three smaller group home works have to be approved before taking a re-exam.
Eksamen:	Hjemmeopgave udleveres den 11. juni og afleveres den 15. juni 2012. Reeksamen. Hjemmeopgave udleveres den 20. august og afleveres den 24. august 2012.
Bemærkninger:	Max. 65 students; master students from Molecular Biomedicine and Bioinformatics have priority as the course is compulsory for these programs.
Undervisnings-sprog:	Engelsk
Sidst redigeret:	7/11-2011

B Evaluation questionnaires handed out to students at the end of each session

Evaluation of the teaching on Tuesday April 24th 2012

Mention 3 things that you learned today?

a)
b)
c)

How did you experience the structure of the teaching?

Do you feel that the exercises increased your learning outcome enough given the time consumption?

What was the best and what was the worst about the structure of todays teaching?

How did the academic level meet your expectations?

Extra question on the evaluation questionnaire from the third session.

Evaluate the 3 different teaching methods used on this course?

13

Imparting basic plant recognition and identification skills - challenges, resources, practicalities

Oliver Bühler

Forest & Landscape, SCIENCE, University of Copenhagen

Introduction

Establishment of comprehensive plant knowledge is identified as one of the major ambitions of the newly established four-year study programme *Have- & Parkingeniør*, Urban Landscape Engineer. From the very start of the programme, the students are supposed to steadily increase their knowledge of and about plants. The course I am teaching (Plants and Climate in Urban Areas, 15 ECTS) is one of the main courses to actively pursue this goal. However, building comprehensive plant knowledge is time consuming and requires substantial independent student activity.

The first challenge in this process is to recognize and identify plants correctly, using and mastering the international botanical nomenclature instead of (or in combination with) Danish common names (Virtanen & Rikkinen 2010). The majority of the students have no previous knowledge of Latin or Greek, therefore the botanical nomenclature is for them a new language to learn. As with all new languages, pronunciation and orthography are challenges for the students, too.

There are different resources for teaching and learning plant identification and recognition, ranging from a broad variety of books, catalogues and other literature to interactive homepages and software.

In addition, plant collections have a long tradition in botanical education at university level, but in recent years have been subjected to severe budget cuts. In 2011, Forest and Landscape Denmark established a new, very practically oriented collection called the Urban Tree Arboretum

(UTA). This arboretum contains many of the relevant species and cultivars and is supposedly a valuable educational tool for our students.

However, it is my impression as a teacher that the students obtain little new knowledge during the traditional excursion to the UTA or other plant collections. Although the students are highly motivated and seem to listen attentively to the guide, the next classroom session reveals that for the majority of the students, no new plants have been learned. Part of the explanation of this experience may already be evident from the description above: the students are merely listening and looking, whereas a deep learning process requires commitment and activity.

Objectives

This project aims to (A) identify challenges and resources regarding teaching and learning plant recognition and identification and (B) evaluate current teaching activities. The knowledge obtained is incorporated into the development of teaching and learning materials in general and into the development of a set of UTA field exercises in particular. Furthermore, the results are supposed to help create a structure for blended learning, where a variety of face-to-face learning situations both in the classroom and in plant collections are blended with independent learning activities designed by the teacher or the students but controlled by the students alone – as described by, among others, (Virtanen & Rikkinen 2010). In the long run this includes the use of electronic resources, both for classroom activities and for independent, self-regulated studies.

Research methodology

All first (HOPI15) and second year students (HOPI14) of the Have- & Parkingeniør study programme were invited to participate in a web-based anonymous questionnaire with nine questions. Of the fourteen available second year students, eight (57 %) answered the questionnaire; of twenty-two available first year students, thirteen (59 %) answered the questionnaire.

The second year students had experienced traditional guided visits of several plant collections during their first year without activating exercises, whereas the first year students were supplied with sets of questions and

tasks or missions during two visits (UTA, the hedge and vine demonstration plantings at SCIENCE Frederiksberg). Plant education was generally provided in a much more structured way for first year students, and plant education is much reduced during the second year of the study program.

Five first year students and two second year students (volunteers) were subsequently interviewed as a group in a semi structured interview in regard to their learning strategies and activities as well as any ideas that might contribute to increase the general learning success. This interview was performed by the author while a second teacher involved in plant teaching took notes.

For the sake of simplicity, answers from first and second year students were pooled (with the exception of the introductory question asking for a self-assessment of own plant identification skills). In the following text, only those results that either had or will have direct consequences for teaching are reported.

In addition, teaching experiences and examples are included where appropriate.

Results and discussion

Challenges and resources – questionnaire, interview and teaching examples

The majority (69 %) of the first year students estimate that they are able recognize many plants by their common names . Only 15 % state that they feel they have obtained sufficient expert knowledge to recognize many plants with the correct botanic nomenclature. None of the first year students admitted they were able to identify only a very few plants.

In contrast, second year students seem to either have lost some of their plant knowledge during their second year of study – or their first year learning outcome was smaller. Here, only 50 % state that they are able to recognize plants by either their common or botanical name, and 25 % stated that they recognize only a very few plants. Various reasons for this difference can be discussed. One obvious reason is that plant identification is not as significant a part of the second year course as it is of the first year. However, another important point is that this cohort of first year students have been subjected to a somewhat restructured plant education.

When asked about the perceived challenges, plant recognition is reported as challenging or very challenging by 54 % of both first and second

year students. Danish names are memorized much easier than botanical names:

No respondents find it very challenging and 23 % find it challenging to remember Danish names, while 48 % find it very challenging and 42 % find it challenging to remember the botanical names.

In addition, 69 % of the students find it challenging or very challenging to pronounce botanical names and 77 % find it challenging or very challenging to write botanical names. This emphasizes the need for working actively with the linguistic aspects, and one approach is to work with translations of the botanic names. This was attempted in 2012 with the first year students in the form of a working document that followed us throughout the course and could be edited by both myself and the students. For every new species we met, we tried to translate its genus or species name from botanical Latin to Danish. During the course, the students became increasingly familiar with botanical names and it was both my clear impression as well as mentioned in the interviews and the course evaluation that it helped greatly to be able to know the meaning of botanical names – one student mentioned specifically that it helped him to remember the plant when he was able to relate its name to a specific feature, a historical person or whatever else might be hidden in a name.

In the questionnaire, 84 % of the students state that a collection of living specimens of relevant species should be in their immediate vicinity (i.e. at Skovskolen, Forest and Landscape College). In the interviews, the students expressed the view that their campus in its current state is too forestry oriented and that it, due to the location of Skovskolen and poor connection to public transport, takes too much effort to visit plant collections in other places (arboreta, Science Campus Frederiksberg). This is emphasized by the fact that many students have the possibility and choose to live on the campus. In my personal opinion this recommendation has to be taken seriously, as it is necessary to make the new students feel at home at the campus at Skovskolen and not just an appendix to the very successful study programme Skov- & Landskabsingeniør, Forest and Landscape Engineering.

76 % express that they depend heavily on repetitions in order to be able to learn to recognize or identify new plant species. This is further elaborated in the free text answers and the interviews, and it not only covers treating the same species repeatedly but also treating it from different angles and in different seasons. Also visits to plant collections should be repeated in order

to be effective: 84 % of the students state that repeated visits are important or very important for their educational effect.

Classroom activities

Surprisingly to me, 61 % of the students stated that they experience classroom activities as efficient in order to learn about plants, and only 8 % stated that they experienced difficulties transferring knowledge obtained in the class to the real world. As a teacher I was under the impression that classroom learning of plant identification was at best second to the real experience and at worst an extremely boring display of vast number of plants. However, it seems that both teacher-based presentations, student-based presentations and exercises with plant material are experienced as rewarding.

This is further supported by free text answers about efficient plant learning methods:

> "Giving and receiving presentations from/to other students."
> "Plant material that has to be identified and added to a scrap book (e.g. as drawing)."
> "Memorizing games with pictures og plants we have to identify."
> "Plants should be a part of every teaching session – short but frequent repetitions."

These findings have contributed to a number of new classroom activities. As an example, the so-called *Plantestafet* has become an inherent part of each course day. For this rather playful approach, one student has to prepare a presentation of a course-relevant species complying with a challenge defined by his predecessor (e.g. the plant should remind you of your mother-in-law or the plant should be beautiful but deadly etc.). This exercise is almost totally self-regulated by the students, i.e. the presenter decides who is to be the next presenter and what challenge he or she has to meet.

In addition, we have designed an exercise with an internet-based application (www.socrative.com), where the students anonymously type the botanical names of plant examples shown simultaneously on a PowerPoint presentation. The typed names can then be displayed as a list, where it is easy sort to out correct and incorrect answers.

This is further supported by a number of small exercises with a duration of between 10 and 30 minutes where the students have to work with plants

via a specific angle, as for example sorting plants according to phenological features (e.g. flowering time) or finding species or cultivars with specific features (e.g. columnar, edible, native). These exercises can, depending on their complexity, be solved individually or in groups, and they are fairly easy to prepare and evaluate. The students state that they experience these exercises as rewarding and enjoyable, and 72 % state that they are efficient plant learning tools.

Visits to plant collections

Plant collections are recognized as efficient resources for plant learning – in earlier studies (Bühler & Kristoffersen 2009, Taraban et al. 2004), but also by the interviewed students. Of the stuents asked, 85 % state that provided they are guided by competent experts, visits to plant collections provide a good or very good basis for learning to identify plants. However, without a guide, only 38 % of the students estimate that visits to plant collections are rewarding in terms of the learning outcome. Another important aspect to the students is the time factor: 62 % state that they need to spend sufficient time in plant collections. In addition to expert guidance, correct labelling of the individual plants is considered an important prerequisite for successful learning.

The most visited plant collection for the students was the UTA (84 %), followed by LIFE's arboretum in Hørsholm (77 %) and LIFE's plant collections at Frederiksberg Campus. Only 23 % stated that they had visited the University Botanical Garden or that they had used the plant collections at Roskilde Teknisk Skole, where parts of their studies are conducted. Whereas the plant collection at Skovskolen (their home campus) has been visited by 92 %, this is by far the poorest and least relevant collection of plants for the *Have- & Parkingeniør* programme – further supporting the need for a relevant plant collection.

The weakness of the traditional guided plant collection tours (similar to what the second year students experienced) might be what could be termed the serial perception of plants, i.e. one plant is viewed after another without establishing any relations between the different observed plants or between the observed plants and other learning activities or the observed plants and real life plant use.

In contrast to this serial perception, a relational approach could trigger deeper learning and increase long term memorization success (Tunnicliff 2001). This relational experience of plant collections could be facilitated

by a set of exercises, by questions, but also, referring to the questionnaire, by giving the students time. A specific example of how to encourage relational perception of a plant collection could be comparing features as for example, leaf morphology or crown habitus between species, or try to elaborate recommendations in regard to plant use. The latter is also mentioned by one of the students in the free text answer to the question about further efficient plant learning methods: "Linking the species with a specific location – e.g. plane trees at Halmtorvet, birch trees at SEB bank. It is easier to remember them and their specific characteristics when I am able to recall them from real situations". The examples of exercises presented in the appendix have been developed focusing on relational perception.

Tunnicliff (2001) points to an aspect often forgotten in factual-based university education. According to her, aesthetic or emotional experiences may contribute significantly to the learning outcome, and it seems that factual memories associated with a state of affection or emotion are much easier to recall. Questionnaire answers also give a hint that aesthetics can trigger learning, as one of the free text answers to the question of efficient learning methods indicates: "Visiting nurseries, in particular when the trees are flowering".

Aesthetic experiences could rather easily be integrated in teaching and learning activities. Examples of how this is encouraged we could mention a photography competition, visits to flowering fruit yards and classroom exercises with flowering species.

Importance of exams

The first students of the described study program were not tested in regard to their skills in plant identification. Instead, each student was assigned to compose four plant descriptions that had to be delivered in print as well as a short PowerPoint presentation. Combined, the plant descriptions would closely match the number of species that we as teachers had defined as the learning goal. It was our assumption that working with plants on this detailed level would trigger deep learning and facilitate learning of the remaining species – helped by the presented work of co-students. However, after completion of the course most students were far from able to recognize and identify any plant species beyond their assignments – and even the assigned species were not thoroughly learnt. In the questionnaire, 38 % of

the students would agree that working in-depth with individual species is a good way to learn plant identification.

Therefore, we redesigned the plant-learning-theme drastically in the following year. Here, the students received a list of 100 plants that we expected them to be able to identify at the end of the course. Shortly before the ordinary exam we scheduled a plant-identification test that had to be passed in order to be allowed to attend the ordinary exam. We provided the students with ideas and examples to design and structure individual learning activities and used classroom time to work on a selection of the 100 species, making it clear that the students were supposed to learn the remaining species on their own. The results were convincing: from day one the students showed great initiative and eagerness and worked individually or in groups with self-developed learning tools such as memory-games, slide shows or index cards.

In order to pass the test, the students were required to correctly identify thirty out of forty randomly chosen plants from the plant list, and out of twenty-four students all but one passed the test with in general good to very good scores.

The students themselves seem to recognize the stimulating effect of the threatening exam – 46 % of the students answered that having to pass an exam increases learning activities. However, 15 % state that an exam obstructs their learning. This was emphasized by some of the students in the interview, who stated that extreme nervousness either prevented them from efficient learning or from recalling information in the exam situation. The interview also suggested that the most nervous students were often students coming from practical careers who had lost familiarity with the exam situation. As this high degree of anxiety was recognized early, we teachers tried our best to create a safe learning environment and to prepare the students for the exam situation, e.g. with mock-exams conducted in a rather playful atmosphere.

Still, the clear impression remains that expecting the students to pass an exam makes them recognize a direct importance or urgency of the respective subject and helps them prioritize their efforts. In the future, plant identification tests will be incorporated in additional courses in order to ensure continuing progression of plant identification skills.

Concluding remarks

This project is by no means concluded. Plant education on the *Have- & Parkingeniør* programme needs to be continuously developed and improved. For this, the questionnaire, the interviews and teaching experiences from the two first years of the study programme provide valuable hints at where to focus.

First of all it is necessary for me as a teacher to continue, increase and develop the use of small (10-30 minutes) classroom exercise units. Those units would serve multiple purposes: The students can work with plants from various angles; they could be opportunities to repeat plants; they can be used to relate to plant visits. All this has been initiated on a small scale but needs to be structured and elaborated. Visits to plant collections are experienced as worthwhile, provided that there is a competent guide, enough time and a set of assignments encouraging the students to actually work with the collection. A focus area for further blending of teaching and learning activities could be promotion of the students self-regulated, individual learning.

The optimal solution would be the establishment of a plant collection on the main campus of the study programme. Due to building activities starting up this scenario is not unrealistic.

Plant identification tests should be incorporated in further relevant courses. The simple version could be a number of online tests that the students have to pass in order to be accepted for the regular course exam.

A Example exercises for visits to plant collections

Træer i vintertilstand Øvelse på bytræarboretet.

1. Beskriv forskelle mellem ***Acer campestre*, *Acer platanoides* og *Acer pseudoplatanus*** i vintertilstand – bemærk især knoppernes udseende:

2. Nævn kendetegn for ***Aesculus hippocastanum***, og giv et bud på om/hvordan *A. hippocastanum* kan skelnes fra *A. carnea* i vintertilstand?

3. ***Fraxinus pennsylvanica*** er et muligt bud på en askeart som er modstandsdygtig overfor asketoptørren. Beskriv ligheder med og forskelle til ***Fraxinus excelsior***. Vurder, om den vil kunne erstatte den almindelige ask i forhold til udtryk og vækstkraft..
    a. Er der forskel mellem *F. excelsior* og *F. ornus*? Beskriv.

4. Beskriv **forskelle mellem lindearterne** – se på habitus (kronearkitektur), vækstkraft og gren- og knopfarve.
   Tilia cordata
   Tilia euchlora
   Tilia platyphyllos

5. Flere arter/kultivarer har noget særligt at byde også i **vintertilstand**. Find arter/kultivarer, som er iøjnefaldende pga:
    a. Grenfarve
    b. Bark (f. eks. struktur eller farve)

6. Find 3 arter/kultivarer du vurderer som specielt egnet til formklipning.
7. Find 3 arter/kultivarer du vurderer som specielt uegnet til formklipning.
8. Find 3 arter/kultivarer, som naturligt danner en smal krone (ikke søjleformer)
9. Find 3 arter/kultivarer, som er særligt vækstkraftige.
10. Find 3 arter/kultivarer, som er mindre vækstkraftige og kunne anvendes i en villahave.

Øvelsesopgave i Bytræarboretet- sommer

Giv forslag til træ (art og klon) for flg. landskabsarkitektoniske situationer:

Lyst og let løvtag over udeservering: ……

Stram allé plantning på kirkegård ……

Løs trærække af store træer langs landevej: ……

Højt lægivende træhegn: ……

Løs trægruppe på vejhjørne ……

Stram trægruppe på gadehjørne ……

Stort solitærtræ: ……

Mellem solitærtræ: ……

Lille solitærtræ: ……

Fin stammehæk på gågade: ……

Hver studerende vælger én art/klon for hver situation. Plantevalget diskuteres i studiegrupperne og fremlægges så for de andre.

Hække om vinteren - **Øvelse i hæksystemet, Rolighedsvej 23**

1. Nævn de vintergrønne hækplanter, du kan finde
2. Der demonstreres 3 forskellige arter/kultivarer af *Ligustrum*. Er der forskelle mellem dem? Hvis ja: Giv en kort beskrivelse. Gør det samme for de to arter *Buxus*.
3. Find arter af hækplanter, som er nåletræer, og vurder deres egnethed til formålet.
4. Find 4 arter med torne.
5. Nævn 3 arter, som er velegnet til en meget tæt hæk.
6. Nævn 3 arter, som er bedre egnet til en løst opbygget hæk
7. Blandt de præsenterede planter er der både buske (basitonisk vækst) og træer (akrotonisk vækst). Nævn arter som uden beskæring ville udvikle sig til træer og arter, som ville udvikle sig til buske.
8. Hvilke generelle egenskaber kendetegner en god hækplante?
9. Hæksystemet klippes to gange årligt for at bevare den præcise form. I hvilke tilfælde bør man overveje en uklippet hæk, og hvilke arter egner sig her? Giv nogle forslag.

14

Effect of research based teaching on student learning and motivation

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Introduction

Effective teaching at university level requires a great deal of research related activities. This is a common belief among both politicians and academics who design strategies for optimizing the teaching at university level (Webster 1986). Teaching and research are often viewed as mutually supportive and indistinguishable in a dynamic and fruitful university environment. This view is not surprising since both activities form a cycle where new scientists are trained to discover new science which in turn is transmitted to the next generation of scientists.

However, recent research trying to map the correlations between research and teaching has not supported the above general belief that research-based teaching results in enhanced student learning. In fact, most investigations have revealed a zero or minimal positive correlation between including research in teaching and the effect on learning (Hattie 1996). This surprising finding is very important and should lead us to consider why and how we should employ current research in the class room. If no positive outcome results from including research in teaching we should not bother spending the time on activities that might need a significant effort from both the student and the teacher. However, although no positive correlation exists between research and teaching in academia these investigations might not have distinguished between particular elements in the research-teaching relation and the result may therefore be a convolution of several factors contributing negatively and positively to learning outcome.

Students do appreciate having teachers who present research conducted by themselves which gives the material some authenticity compared with presenting some facts from a book. Also, researchers who actively pursue new knowledge have a critical view on science and can demonstrate to the student that new research findings are often contested for a long time before being accepted as facts or even modified before being accepted as facts. Moreover, nobody would deny that a devoted researcher presenting exciting cutting edge research (even if it is disputable) would enhance motivation and curiosity in many students. These positive effects are not easily measurable on a grade scale but should not be underestimated since they give the student the endurance to stay motivated and finish his or her education whereas a good grade merely gives a brief satisfaction to the student.

On the negative side of the research-teaching relation we can imagine that some researchers spend a lot of time on research and consequently give lower priority to their teaching responsibilities. In fact a negative relation has been measured between the time spent on teaching and time spent on research (Olson & Simmons 1996). Researchers do not get much credit for improving their teaching but instead can improve their career by publishing important research findings. This poses an obvious challenge to universities and makes research and teaching competing activities instead of mutually supportive activities.

In this project I have tried to test the effect of including research in my own university teaching. The aim was to elucidate the effect of three different activities on the learning process and to test the motivational effect of these activities on the students. The outcome of these activities would be monitored in the exam, where I was an examiner myself, and also I used an evaluation scheme in which the students could express their opinion about the three research activities. The course was an introductory course in biophysics with eighteen students who also attended the exam.

Research based learning activities

First activity mandatory project

I designed a research related project which was mandatory to pass in order to register for the exam. The project involved reading a recently published paper about membrane-curvature generation of proteins (Heinrich et al. 2010). The paper is relatively easy to understand and contains some

equations which the students have the background to understand. Although the scientific level was not too complex the paper is interesting and has a central place in literature regarding the membrane-curvature generation of proteins. Moreover, the content of the paper overlapped significantly with the curriculum. Experimental techniques used in the paper were a part of the curriculum and also topics like bio-membranes and the concept of diffusion were heavily treated in the paper as well in the course text book.

Papers can be quite hard to read for undergraduate students who are only used to textbooks that contain all the necessary background information and only treat material relevant for a course. Therefore it was important to assist the students in approaching the project by defining questions and points that were important for the curriculum. The students were asked to give a summary of the paper with emphasis on certain points which were given in the assignment. To assist the students in focusing on the essential parts of the paper, a set of questions were defined where the student should explain the functioning of an experimental technique or perform some relevant calculations.

The devolution of the project was also accompanied by a lecture held by a researcher who worked with exactly the same scientific problem as in the project paper. Also, in conjunction with the project, a visit to our lab showed the students how we conduct experiments similar to those described in the paper, and the students were allowed to play around a little with the equipment.

Finally, the students were allowed to ask questions and discuss the project with the teachers of the course (myself, the course responsible and the instructor) for four hours. This way we could eliminate any confusion and misunderstanding that had occurred for several of the students.

A total of eighteen students handed in the project work and all eighteen projects were very well answered. Even though the projects were not graded some of them far exceeded any expectations I had. My impression was that the students liked the project and found it interesting to work with real science instead of just reading a standard text book. During the question hours I also received direct feedback from students saying that the project-paper was really interesting to read and work with.

Second activity: paper presentations

To train the students in critically reading scientific papers the students were asked to present a paper for their fellow students. Moreover, a few of the

students should act as peers and prepare questions to ask the presenter and hopefully initiate a discussion.

This activity was a mixed success. The chosen papers had very different levels and their relevance to the curriculum differed somewhat. The first paper was very old and the formalism was hard to understand. This resulted in little discussion and the students seemed uninterested and frustrated by this paper. However, the other two papers were more up-to-date and seemed to catch the interest of the students which resulted in more lively discussions.

Third activity: guest lecturers

Finally, researchers were invited in to give brief talks about their research. Again to enhance learning the researchers were chosen such that their research overlapped with the curriculum. The topics included X-rays of proteins, and two lectures about membrane physics with two very different scopes. This activity was generally very passive for the students. In two of the lectures the students seemed tired and the level of the lectures appeared too high. However, in the one of the lectures, about bio-membranes, the students were very interested mainly because the lecturer was able to give the students the impression that all current knowledge about the topic was potentially incorrect despite several Nobel Prizes having been given for the discoveries. This triggered a lot of questions from the students and the lecture went forty-five minutes overtime due to students interrupting with questions.

Evaluation of activities

To gain insight into the effect of the research based activities on learning and motivation the students received a questionnaire where they were asked to evaluate (1) the level of all the activities, (2) the effect on learning and (3) the motivational factor. The questions are listed in the appendix.

A total of sixteen students handed in the questionnaire and the answers are summarized in figure 14.1.

The overall impression of the activities was very positive. In particular the project was a success according to the students: fifteen out of sixteen students stated that the project strongly supported learning (Fig. 14.1B) and all students rated the project as inspiring or somewhat inspiring (Fig. 14.1C). In the evaluation scheme the students could give optional comments

about the activities. Several students wrote explicitly that the project was highly interesting and had stimulated their learning. A couple of examples:

> "I learned most from the project, because we had to work with it for a longer period of time; would have liked two small projects just because I learned most from it, and the articles and lectures were just listening."
> "The mandatory project was awesome."

The success of the project was also consistent with the student's perception of the level of difficulty: fourteen out of sixteen students answered "not too difficult", see figure 14.1A, and one student thought it was easy.

The other two activities were also perceived as supporting the learning process but to a lesser degree. These activities were more appreciated with regard to the inspirational value which was emphasized in the evaluation (Fig. 14.1) and also in the general comments:

> "The research in teaching made me interested in specific parts of the subject and that I've got an overview of how we can use biophysics is really what is amazing"

Almost 50 % of the students thought the guest lectures were too difficult which was also apparent in many of the general comments. However, many of the comments were ambivalent towards the guest lecturers since they were difficult to understand but at the same time the students felt inspired or motivated by the authenticity of a researcher talking about current research.

Notably, none of the activities were perceived as not inspiring by any student (Fig. 14.1C). This agreed well with my initial hypothesis that the students should at least be inspired by working with and hearing about front line research topics from researchers themselves. The overall impression was also positive as shown in figure 14.1D, since all students rated the activities as inspiring or educational. In a final question, the students were asked if they would recommend us to include these activities in future versions of this course and 100 % of the students answered yes.

Discussion

The evaluation was extremely positive but the question remains whether the activity actually supported the student's learning process or merely gave them a satisfaction from working with and hearing about research.

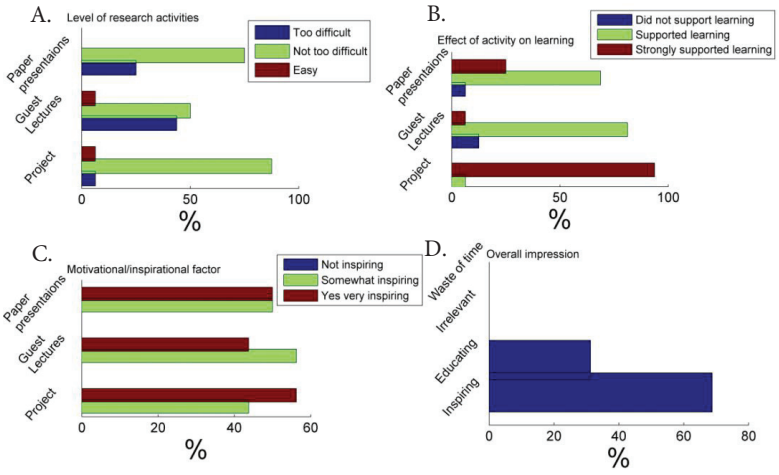


Fig. 14.1. Answers from the students to the questionnaire about the research based activities. A. The level of the three research activities was ranked as three levels of difficulty as shown in the legend. B. The students answered to which degree the particular activity supported learning. C. Evaluation of the motivational and inspirational factor of each activity. D. Finally, the students gave their overall impression was of the activity with four options from inspiring to waste of time.

All the research seems to indicate that students learn best when the teaching is student centred (Biggs & Tang 2007). The research based activities in this course had different degrees of student involvement; the paper presentations were more or less left to the students with a few comments from the teacher along the way or afterwards. The project was highly student centered with the teacher assisting the students but the time spent on this assistance was limited. In contrast, the guest lecturers were highly teacher centered since the students were listening but since the atmosphere was relaxed many students also asked questions which often led to open discussions led by the lecturer.

A framework has been put forward by Griffiths and Healey (Griffiths 2004, Healey 2005) in which research in teaching can be classified into four sub-categories: (1) research tutored, (2) research led (3) research based and (4) research oriented. The framework is sketched in the diagram in figure 14.2.

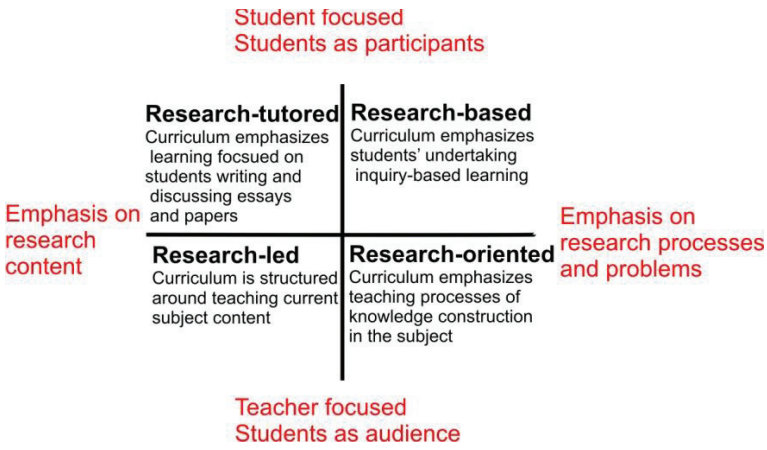


Fig. 14.2. Teaching-research nexus by Griffith and Healey.

Effective learning would include all four parts in figure 14.2 but the emphasis should be on the approaches in the top half of figure 14.2 since here the student is actively participating in the learning process. According to the definition in figure 14.2 the research tutored and research based teaching are highly student centred whereas the research led and research oriented are more teacher centred and the students act more as a passive audience.

The three research activities included in this course cover all four types of the research–teaching nexus presented in figure 14.2. The guest lecturers, being focused on the research and research process and with students as audience clearly belong to the lower half in figure 14.2. In contrast, the mandatory project was highly student centered since it made students look for information, solve problems, ask questions, read a scientific paper and write up their conclusions. Therefore, the project belongs in the top half of figure 14.2. Finally, the paper presentations were also student centred since they included reading, presenting and discussion of papers by the students, mainly, and therefore this activity was research tutored belonging mostly in the top right in figure 14.2.

Conclusion

The effect on learning from the three research activities was clearly most significant for the project work, a conclusion which was drawn from the evaluation of the activities by the students. This activity clearly was the most student-centred and activated the students much more than did the guest lectures or paper presentations which only activated a few of the students. The students' perception of learning was also backed up by my own observations from the exam where I could see that even the weak students knew all the details regarding the subjects discussed in the project.

The learning outcome is only one factor important in teaching, however. Inspirational value and becoming motivated to continue learning more about the subject matter should not be underestimated; with regard to this factor, all the activities scored very high in the evaluation. Moreover, all the students recommended such activities to be included in future versions of this course. This confirms my belief that including research activities in teaching can be fruitful, but they should be carefully designed to motivate and activate students to enhance student learning. Also, the topics should be directly overlapping or relevant to the curriculum to justify the use of these research activities in teaching.

A Questionnaire for the Course: Introduction to Biophysics

I would very much appreciate if you could tell me your opinion about the research based activities which you have been exposed to during this course .

Research related activities:

- Mandatory project based on current research (Curvature generation of N-BAR)
- Three star lectures where research was presented about:
  - -X-Rays
  - -Tubes and curvature sensing of F-BAR
  - -Membrane biophysics
- Paper presentations
- And a single visit to our lab showing how we conduct biophysical experiments

Please mark your answer with a cross below:

1) How was the level of the mandatory project?

Too difficult____ Not too difficult ____ Easy____

2) Did the mandatory project support the learning process?

Did not support learning___ Supported learning____ Strongly supported learning____

3) Did you find the mandatory project inspiring/motivating/interesting?
No____ Yes to some degree____ Yes very much____

4) How was the level of the Star lectures?

Too difficult to understand____ Not too difficult ____ Easy____

5) How did the star lectures support the learning process?

Did not support learning___ Supported learning____ Strongly supported learning____

6) Did you find the star lectures inspiring/motivating/interesting?

No____ Yes to some degree____ Yes___

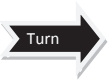
7) How was the level of the papers?

Too difficult to understand____ Not too difficult ____ Easy____

8) Did the papers support the learning process?

Did not support learning___ Supported learning____ Strongly supported learning____

9) Did you find the papers inspiring/motivating/interesting?
No____ Yes____ Only one or two of them____



Did you find the overall effect of the research based activities to be:

Inspiring ____ Educating ____ Irrelevant ____ Waste of time____

Would you recommend us to include these kind of research based activities in this course in the future?

Yes____ No____ Don't know____

If you have any additional comments about the research activities you are most welcome to write them below (e.g. what is good or bad with research in teaching?):

Comments:

Thanks in advance

Part IV

Supervision and supervision styles

15

The performative supervision of PhD students and postdocs as seen through email text mining

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Introduction

Supervision for graduate students and postdocs is different from supervision in a class. Obviously, PhD students, and, to a greater extent, postdocs are the most successful and smartest students from any given master's programme. Bluntly, they are all Susans, if one looks at it according to Biggs & Tang (2007). The point is not to force-feed knowledge or know-how into them. They (by definition) are used to looking for knowledge themselves and should be independent enough to learn what they need. Rather, the goal is to teach them to become autonomous researchers, able to produce knowledge themselves. The hypothesis is that, unlike regular short term learning sessions with clearly defined intended learning outcomes, the supervision of PhD students is performative in nature. The argument goes like this. Given a task as general as becoming a researcher from being a student (however bright) is a process that is performed via and together with a bunch of different actors in an heterogeneous network of diverse material (human or not). The supervision is per se the reiteration of interactions between all the actors of this network. For instance, supervision acts can occur by email, informal talks, or meetings; this may also happen face-to-face or via a computer with Skype or by telephone, possibly using a fax machine. The student can be supervised by his or her main supervisor, by a speaker at a conference, but also by another fellow PhD student, or wikipedia. All these, together with computers, office space and university buildings, act together and are translated (produced) into supervision for each student.

By un-blackboxing this heterogenous network, we may understand what is important for its stability, what repeated interactions hold it together. For example, if you take away my computer, my email program, my desk, my computer cluster, and the biologists producing data for me, I can barely call myself a bioinformatician, but I may still be able to supervise a PhD student in bio-informatics. Still I would argue that we live in a physical world, thus, no version of the social order, no organization, and no agent, is ever complete, autonomous, and final. Consequently, a relatively stable network is one embodied in and performed by a range of durable materials (Law 2004). What is then important for the supervision of PhD students? What are the durable elements of the networks that need to perform so that supervision is achieved? I have decided to focus on my own research group which has the particularity that we are all bipolar scientists, i.e. bioinformaticians. By this I mean that we perform our scientific agency in-between two traditional fields of science, which is a similar situation as to that described by Cussins (1996), except that we talk biology and computer science instead of patients or doctors.

The structure of the group is composed of a group leader who has a background in machine learning (and consequently spends most of his time at the technical university where he has a permanent position), one postdoc (currently myself) and four PhD students. Durable elements with which we interact daily are our computers, the university building, and talks given every Wednesday morning. As scientists, we normally translate knowledge based on experimental data, that come in the form of emails, folder sharing, and hard drives sent by post. One crucial element is that we are connected to the real world of data through our computers. Everything goes through them (in and out), data, communication, results, presentations, even the articles we produce are ultimately displayed on their screens. With this in mind, it become relevant to look for traces of supervision inside them, and look for tangible facts that are recurrent and substantial.

Emails last longer than thoughts, talks or even lectures. An email is a physical proof of some communication between the student and the supervisor. For our research group, they are even more critical, because they represent a fair amount of the communication we have, and can be considered a hub of the network (because we send emails on a more or less daily basis). For that reason I have decided to analyze them; on top of that, they are also easy to read by a computer, so I can have my Apple Mac labtop read 200 000 emails in an instant. The idea behind the experiment, is to look at the emotions that are expressed in the email communication

between the students and the supervisors (SV). We of course take care of removing background emotional trends, irrelevant emails. We also use a set of PhD students from a purely experimental group for comparison.

Methods

Email Scoring Scheme

A program was written with the purpose of text mining emails from the students' computer (with the consent of the students of course). In order to respect the privacy of everyone involved in this study, the students had the responsibility to modify the program so that it would work for their specific case on their machine, producing anonymized data for the analysis. They had to set up the program with their own name and the name of their supervisor as well as if the conversation was in Danish or in English. For all the participants, the program would try to categorize all the emails in the computer in order to find emails that were written by the student to the SV, the ones written by the SV to the student, and all the other emails, that were used as background for the analysis later on. Each email is analyzed to look for words implying a given emotion or feeling (see Appendix B for the list of words).

The programs return the counts, that is how many words of feeling type X it has seen for each email. For example, the dummy email in the appendix scores the following:

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1]
```

The word "great" is recognized once so we put one in the category where it belongs. None of the other categories of feelings are found in this email.

In the end of the run, three matrices are produced:

- the supervisor $\rightarrow$ student matrix, where all the emails that are exchanged solely between the SV and the student are scored. One may ask why I did not include the emails between the SV and the student plus other recipients. The reason for this is simply because it may be that writing to several people forces the SV to be more general or formal in his or her communication and that the message may not concern the student only, therefore introducing some bias into the later analysis.
- the student $\rightarrow$ SV matrix, where the emails from the student to his or her SV are scored.

- the background matrix. This matrix tries to approximate the normal distribution of the emotions of the student based on all the emails. This information is used primarily to score the first two categories of emails based on the Shannon information theory concept of entropy (Shannon 1948)[1] , and more precisely the Kullback-Leibler relative entropy (Kullback & Leibler 1951)[2].

Time plots

These profiles show the feeling count for emails received over time. A detailed plot shows the counts for all emotions, while a summary plot shows the emotions based on wether they are positive, or negative.

Positive feelings are: good, love, positive, alive, strong, interested, open, happy. Negative feelings are: depressed, angry, confused, sad, hurt, afraid, helpless, indifferent.

Rose plots

These plots display a visualization of the Kullback-Leibler divergence (KL divergence) for each feeling category. In short, given a background probability Q(i) for a given emotion i, and P(i) the actual probability observed in the student $\rightarrow$ SV or SV $\rightarrow$ student emails, the KL divergence can be expressed as the average of the logarithmic difference between the probabilities P and Q, where the average is taken using the probabilities P. In practice, I use this measure to find out if a given emotion is over-represented in the SV $\rightarrow$ students emails compared to the background. I compute this measure for SV $\rightarrow$ student and student $\rightarrow$ SV emails, and calculate their ratio so that I can estimate if one emotion is over-represented in one direction of the communication. The rose plot is a representation of this, where the higher the bar, the more over-represented or observed the feeling is in the email communication. A blue colour shows that the emotion is more often seen in the student's emails, while a red colour shows that the emotion is most often seen in the communication coming from the SV.

[1] In information theory, entropy is a measure of the uncertainty associated with a random variable. In this context, the term usually refers to the Shannon entropy, which quantifies the expected value of the information contained in a message. http://cm.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf

[2] http://projecteuclid.org/DPubS?service=UI&version=1.0&verb=Display&handle=euclid.aoms/1177729694

Correlation

Pearson correlation is used to find correlation between emotion count profiles for student → SV and SV → communications.

Principal component analysis

Each student and SV pair is analyzed on its own, then all the data about feeling over-representation is subjected to principal component analysis (PCA). Very briefly, the PCA plot places things that are similar (in the sense that they vary in a similar way in a dataset) close to each other. The axes are the principal components which are those that have the largest influence on the variation of the data. What these principal components represent is to be determined afterwards. For example, one would expect to see Happy and Sad at opposite sides of the plot.

Results

The program has analyzed and scored a total of 182 838 emails, including 4891 emails sent from students to their SVs and 2681 emails sent from the supervisors to their students. A total of twelve pairs of student-SV communication channels were analyzed comprising three postdocs and nine PhD students. Five of these had a purely biological background, typically with one supervisor also with a biology background, the remaining eight had a bioinformatics background of which five had two supervisors; a bioinformatician and a biologist.

The PCA plots made from student → SV communication for both the experimental (biology) group and the bioinformatics shows that students and postdocs, on average, tend to express similar emotions in their emails, with differences (Fig. 15.1). On both graphs, some feelings are associated, meaning that they are often seen together in emails: (1) positive and interested, and (2) helpless, hurt, angry and sad. Bioinformatics students have a cluster of mainly bad feelings (helpless, confused, angry, afraid, strong) that sit on one side of the PCA plot while more positive feelings (positive, interested, love, open and indifferent) sit on the other side. Interestingly, sad and happy are in the middle of the graph, showing that neither of those feelings are expressed often, or are correlated with other feeling. One can

also interpret this as a common feature for all students. Looking at individual rose plots shows that these emotions are not over represented. Bioinformaticians are neither happy nor sad in the way they communicate. This behaviour is not observed for experimental biology students, where the supervisors tend to express more happy feeling towards them. On top of this, biology students have a cluster of negative feelings (sad, hurt, angry) in the middle of the graph (so the principal component values are close to zero), which shows that these feelings have little influence in explaining the data and all students feel the same with regard to these emotions, in short, the email communication is not negative. The negative emotion that sits furthest away from the others is "confused" which may actually reflect the fact that, as scientists, students try to explain difficult results or concepts and that the communication is not always perfect; being confused is a positive thing in the setting of research, because it is associated with interest from the supervisor.

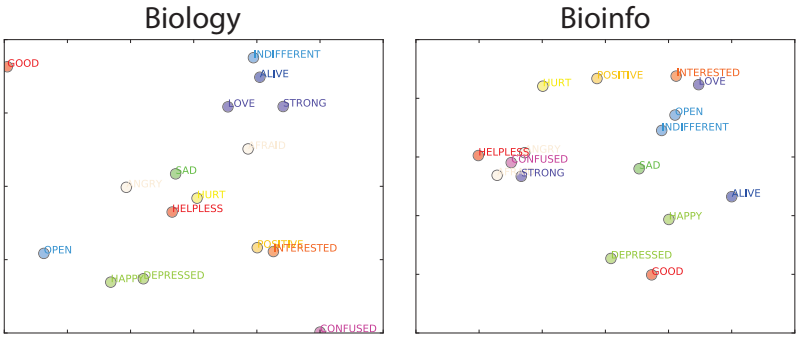

Fig. 15.1. PCA plots of emotion co-variation in biology (left) and bioinformatics (right) students. Emotions that are close to each other in these plots have a similar behaviour, or are expressed similarly by the two groups of students.

Figure 15.2 shows the differences in SV → student and student → SV communication. SVs tend to associate indifference and depressed feelings; afraid, open and helpless also behave in the same way. Confused is clearly being outside of the bulk of feelings together with interested. From the individual rose plots, it seems that confused is scoring very high especially for three of the students, with the supervisor over-expressing confusion.

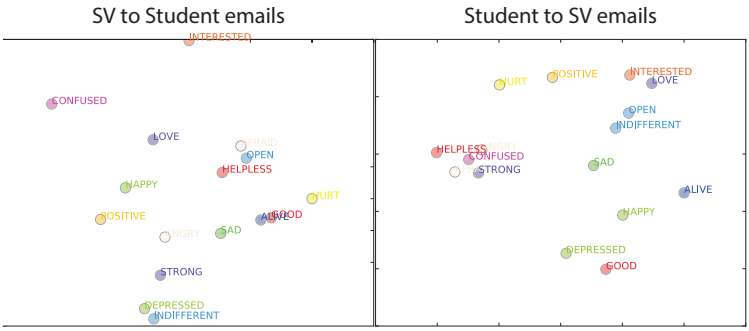

Fig. 15.2. PCA plots of emotion co-variation in SV → student (left) and student → SV emails (right). Emotions being close to each others in these plots have a similar behaviour, or are expressed similarly by the two panels.

Overall, looking at time plots in figures 15.3 and 15.4, the communication seems very positive in all cases, and this may exhibit a clear encouraging tone in the email communication. A small baseline of negative feelings can be observed though, with occasional peaks for some students (who tend to be postdocs).

Emotion	Emotion	Correlation
GOOD	OPEN	0.91
GOOD	HURT	0.87
GOOD	ALIVE	0.83
GOOD	OPEN	0.77
GOOD	OPEN	0.76
GOOD	ALIVE	0.76
INDIFFERENT	DEPRESSED	0.75
GOOD	STRONG	0.72

Fig. 15.3. Emotion correlation on email correspondence between SV and student in the bioinformatics group.

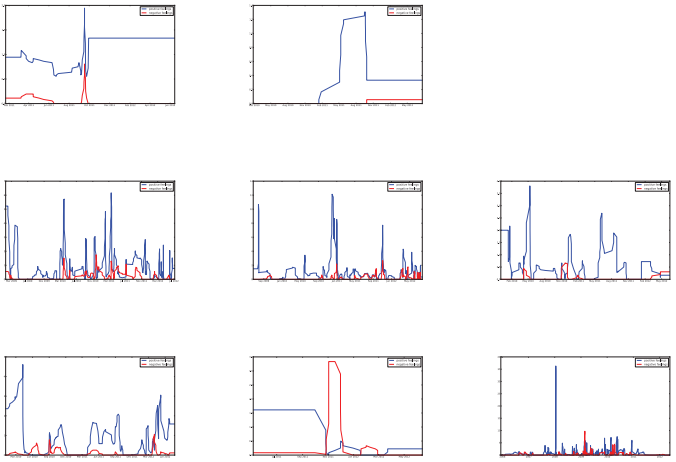

Fig. 15.4. Time plots for student → SV communication. The blue profile shows the positive word counts in emails.

Discussion

If things are working, then they are not described in detail, there is not network, or rather the network is punctualized to one event. One just does not talk about it. It is only if things are broken that the structure of the network starts to be exposed. For example, one talks about a TV set but, if it breaks down and one needs to repair it, then all the components starts to appear and their network becomes clear(er). The network analysis performed here has shown that email communication plays a central role in the supervision of students at PhD level and beyond. This is particularly clear for bioinformatics students. Biology students tend to have a more positive attitude towards email communication, this part of the network is punctualized, probably because most of the resistance in the network occurs during individual meetings and not by emails, unlike in the bioinformatics group.

The text mining of all the emails showed some similarity between the students in biology and those in bioinformatics. One important results is that the analysis has uncovered a general pattern of confusion in the bioin-

formatics group. Individual chats with students from the group revealed a global in satisfaction towards the group and the way it was led and directed. Together with the analysis just performed, it may just be that supervision that is mainly based on emails is not working, leaving the students and the supervisors confused and depressed. In this specific case, one can say that in a small research group unity and repeated physical presence may be the keys to success. No one wants to be left alone.

The method developed here was run only on a small set of students, and it would be very interesting to use a larger pool of students to get quantitative results. Still it has the power to uncover qualitative behaviour and has a great potential. This method could be used, for example, to probe for SV $\rightarrow$ student relationships and tackle potential problems.

Acknowledgments

I would like to thank the students who generously spent time installing and running the program that scanned all their emails.

A Dummy email

Dear XXX, You deserve a break after your great performance last week. We will try to make it without you. Best regards,

YYY

B Feeling word list

The list of words used to score email communication between supervisor and PhD students or post-docs can be found below.

Source: http://www.psychpage.com/learning/library/assess/feelings.html

GOOD: calm, peaceful, at ease, comfortable, pleased, encouraged, clever, surprised, quiet, certain, relaxed, serene, free, easy, bright, blessed, reassured . LOVE loving, considerate, affectionate, sensitive, tender, devoted, attracted, passionate, admiration, warm, touched, sympathy, close, loved, comforted, drawn, toward.

INDIFFERENT: insensitive, dull, nonchalant, neutral, reserved, weary, bored, preoccupied, cold, disinterested, lifeless .

DEPRESSED: lousy, disappointed, discouraged, ashamed, powerless, diminished, guilty, dissatisfied, miserable, detestable, repugnant, despicable, disgusting, abominable, terrible, in despair, sulky, bad, a sense of loss.

POSITIVE: eager, keen, earnest, intent, anxious, inspired, determined, excited, enthusiastic, bold, brave, daring, challenged, optimistic, re-enforced, confident, hopeful . ANGRY irritated, enraged, hostile, insulting, sore, annoyed, upset, hateful, unpleasant, offensive, bitter, aggressive, resentful, inflamed, provoked, incensed, infuriated, cross, worked, boiling, fuming, indignant.

CONFUSED: upset, doubtful, uncertain, indecisive, perplexed, embarrassed, hesitant, shy, stupefied, disillusioned, unbelieving, sceptical, distrustful, misgiving, lost, unsure, uneasy, pessimistic, tense.

ALIVE: playful, courageous, energetic, liberated, optimistic, provocative, impulsive, free, frisky, animated, spirited, thrilled, wonderful.

SAD: tearful, sorrowful, pained, grief, anguish, desolate, desperate, pessimistic, unhappy, lonely, grieved, mournful, dismayed.

HURT: crushed, tormented, deprived, pained, tortured, dejected, rejected, injured, offended, afflicted, aching, victimized, heartbroken, agonized, appalled, humiliated, wronged, alienated.

INTERESTED: concerned, affected, fascinated, intrigued, absorbed, inquisitive, nosy, snoopy, engrossed, curious.

AFRAID: fearful, terrified, suspicious, anxious, alarmed, panic, nervous, scared, worried, frightened, timid, shaky, restless, doubtful, threatened, cowardly, quaking, menaced, wary . HELPLESS incapable, alone, paralyzed, fatigued, useless, inferior, vulnerable, empty, forced, hesitant, despair, frustrated, distressed, woeful, pathetic, tragic, in a stew, dominated.

STRONG: impulsive, free, sure, certain, rebellious, unique, dynamic, tenacious, hardy, secure.

OPEN: understanding, confident, reliable, easy, amazed, free, sympathetic, interested, satisfied, receptive, accepting . HAPPY great, gay, joyous, lucky, fortunate, delighted, overjoyed, gleeful, thankful, important, festive, ecstatic, satisfied, glad, cheerful, sunny, merry, elated, jubilant.

C Rose plots

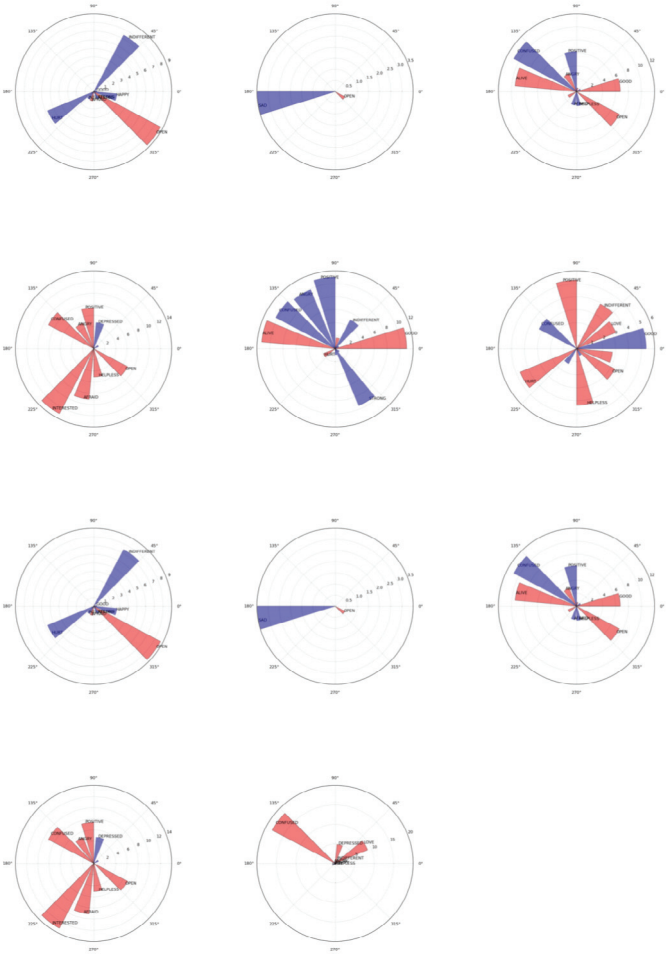

Fig. 15.5. Rose plots for all bioinformatics students.

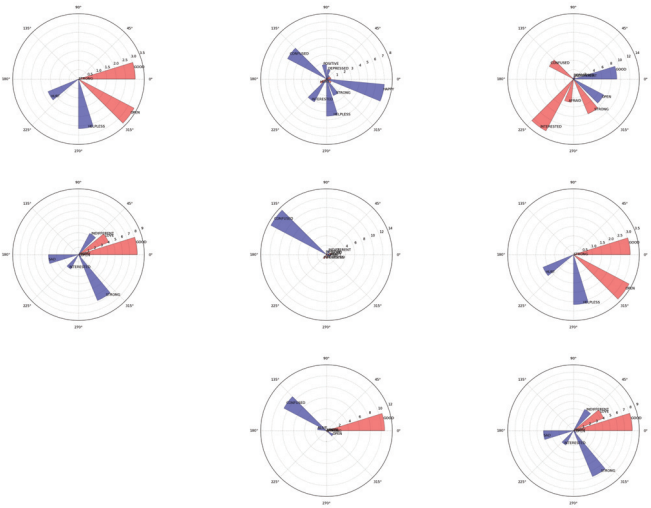

Fig. 15.6. Rose plots for all biology students.

16

Kasket-vejledning: teori- og brugerdreven udvikling af et didaktisk design målrettet vejledning af specialestuderende

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Introduktion & Problemformulering

Denne artikel baserer sig på et KNUD-projekt, der overordnet beskæftigede sig med vejledning som tema, blandt andet inspireret af Ulriksen (2012) og KNUD-forprojektet om vejledning (Olesen et al. 2011). Ambitionen og formålet med KNUD-projekt og denne artikel er således at udvikle praksis inden for (og kontekstbaseret såkaldt ydmyg teori om) vejledning. Begreberne undervisning og læring er komplekse størrelser, for hvilke der ikke findes endegyldige svar (Bentsen et al. 2009). I artiklen vil jeg derfor beskrive og diskutere en række principper, retningslinjer og eksempler, der kan danne basis — som inspiration og argumentation — for en reflekteret og velbegrundet praksis og undervisning. I dette tilfælde vejledning af specialestuderende. Jeg mener ikke, at det giver mening, at tale om rigtig eller forkert undervisning, men snarere om mere eller mindre velbegrundet og mere eller mindre hensigtsmæssig i forhold til den konkrete situation. Det stiller således krav til undervisere om at være bevidste, refleksive og velargumenterede – hvad man kunne kalde styret af didaktisk rationalitet (Dale 1998). Undervisere på universiteter bør tænke didaktisk og forsøge at undgå uovervejet og ureflekteret pædagogisk praksis eller didaktiske-metodiske handlinger alene baseret på vane og tradition (Bentsen et al. 2009). Det er vigtigt at være opmærksom på, at "Veiledning innebærer langt flere valg enn dem man vanligvis tenker på, og valgene tas, selv om det skjer ubevisst" (Handal & Lauvås 2006, s. 53).

Ofte skelnes der blandt undervisere på universiteter og højere læreanstalter mellem undervisning og vejledning. I princippet er vejledning under-

visning eller en form for undervisning (Ulriksen 2011). Man kunne kalde det en-til-en undervisning, hvor der er mindre kontrol (fra underviserens side) og mere deltagelse (fra studerendes side). Ulriksen (2012) diskuterer, hvordan den pædagogiske framing og kontrol er stærk i forelæsningen og ofte svag i vejledningen (og hvilke pædagogiske og dannelsesmæssige potentialer, der kan ligge i dette, for eksempel graden af åbenhed i formuleringen af metode og problem eller indhold). Vejledning er således en undervisningsform, hvor kontrollen og ansvaret for indhold og tempo er delt mere ligeligt mellem underviser og studerende. I min optik er specialevejledning således — eller det kan i hvert fald i nogle tilfælde være — en form for mesterlære (Lave & Wenger 2003, Nielsen & Kvale 1999, Handal & Lauvås 2006) og en vigtig måde at lære forskning og videnskabelig tankegang på (Kjeldsen 2006). Det er en unik mulighed for at udnytte disse en-til-en eller en-til-få situationer. I den forbindelse fremhæver Ulriksen (2012) ligeledes, at vejledning giver en tættere kontakt og formidling, for eksempel af kriterier og fagets kulturer. Populært sagt er vejledning blandt andet et opgør med, hvad nogle har kaldt et-tallets tyranni: en underviser forelæser en årgang i et emne i en time i et auditorium.

Vejledning er (som andre mange andre undervisningsformer) på trods af denne tættere kontakt og de muligheder, der ligger heri ofte en meget ritualiseret undervisningsform (Handal & Lauvås 2006). Både undervisere og studerende har ofte en række bevidste og ubevidste holdninger og forventninger til, hvad der skal foregå, og hvordan det skal foregå. Måske er der behov for at udvikle og eksperimentere lidt med formen? Måske er der behov for at sætte fokus på metaovervejelser og metakommunikation omkring vejledning (og de flere og mange roller underviseren har)? Vejledning udgør en forholdsvis stor del af undervisningen på universiteter — ikke mindst i min egen undervisningspraksis og stillingsbeskrivelse. Udvikling af og overvejelser om vejledning, studenteraktivering og studerendes udbytte og læring virker derfor væsentlige.

Vejledning, kasketter og rollespil

Vejledning er ofte kilde til frustration — ikke mindst i forbindelse med specialevejledning. Jeg har ofte hørt kollegaer fra universitetet udtrykke frustration over specialestuderende, i stil med de forstår mig ikke, vi er ikke på bølgelængde eller jeg ved ikke, om jeg er den optimale vejleder for denne gruppe? Det er heller ikke unormalt, at studerende ople-

ver frustration over deres vejleder, for eksempel florerer der ofte diverse rygter om vejledere blandt studerende i stil med XX er sådan, hun er blød, Jensen er faglig god men hård og så videre. Et mindre spørgeskema blandt adjunktpædagogikum-deltagere tyder på, at flere undervisere finder det vanskeligt at forstå, hvad de studerende har brug for. Andre KNUD-deltagere nævner, at det kan være vanskeligt hurtigt at lære de studerende at kende, så man kan vejlede de studerende til at yde deres bedste (Ulriksen 2012).

Hvis de tidligere nævnte potentialer i forbindelse med vejledning, entil-en undervisning, mesterlære og forskeruddannelse skal udløses, ser det ud til at være vigtigt, at der er alignment mellem underviserens vejledningsstil og de studerendes studiestil og behov (Ulriksen 2012). Flere (Kaae 1999, Ulriksen 2012) fremhæver vejledningskontrakter og -aftaler og metakommunikation (Kaae (1999) taler i denne forbindeles også om metakognition — at blive bedre til at lære at lære) om vejledning, som én måde at imødekomme problemet med alignment og ovenstående frustrationer på. Således kan der sættes fokus på centrale spørgsmål som: Hvordan tolkes rollen som vejleder af den studerende og af vejlederen? I forlængelse heraf pointerer Ulriksen (2012) også, at vejledere og uddannelsesinstitution ofte har en implicit opfattelse af studerende, for eksempel at den studerende ved, hvordan man bruger en vejleder, herunder hvordan man kan og skal bruge feedback. I forlængelse heraf kunne man også reflektere over, om og hvilke implicitte opfattelser studerende eventuelt har af (og hvad man implicit går ud fra hos) vejlederen.

Ulriksen (2012) fremhæver, at vejlederen ofte har flere roller i forbindelse med vejledningen, for eksempel ved at være både vejleder og bedømmer og eksaminator — og at det kan være et problem for eksempel i forbindelse med tilbagemeldinger på næsten færdige tekstudkast tæt på eksamen. KNUD-forprojektgruppe 3 nævner på baggrund af interview med studerende metaforerne mor, ven og chef for forskellige vejlederroller og forventninger til vejlederen (Olesen et al. 2011). Andersen & Jensen (2007) taler i deres bog om vejledning om eksperten, coachen og fødselshjælperen, mens Deuchar (2008) nævner facilitator, director og critical friend.

Ulriksen (2012), blandt andet med udgangspunkt i Kaae (1999), og Kaae (1999) foreslår, at problemet med feedback og de forskellige vejlederroller blandt andet kan løses ved, at vejlederen benytter rollespil og forskellige kasketter, for eksempel ved at sige: nu leger jeg lige den skrappe censor, eller de næste ti minutter agerer jeg reviewer-from-hell. Disse rollespil kan eventuelt afsluttes med, at underviseren følger op som de stu-

derendes vejleder, for eksempel hvad synes du, vi skal gøre ved det? eller hvordan kan vi imødekomme nogle af reviewerens kritikpunkter?

Problemformulering

På baggrund af ovenstående indledning og baggrund ser der ud til at være et behov for et pædagogisk udviklingsprojekt, der sætter fokus på metakommunikation om vejledning og de forskellige vejlederroller i et didaktisk perspektiv. Overordnede forsknings- og udviklingsspørgsmål kunne være i stil med: Hvordan udvikles en bedre praksis inden for specialevejledning? (se for eksempel Gynther (2010)), samt hvordan oplever og hvilken mening tillægger henholdsvis studerende og vejleder de forskelle vejlederroller?.

Jeg vil således arbejde med forstående, handlingsorienterede og transformative forsknings- og udviklingstyper (Launsø & Rieper 2005, Gynther 2010, Ravn 2010) i et kvalitativt forsknings og udviklingsdesign (Gynther 2010, Ravn 2010) i tæt samarbejde med studerende og kollegaer fra adjunktpædagogikum. Mit fokus vil dog overvejende være på praksis, det handlingsorienterede og udvikling (Gynther 2010, Ravn 2010). I samarbejde med studerende og kollegaer ønsker jeg således at udvikle min egen praksis (og kontekstbaseret teori herom) inden for vejledning ved at undersøge og dokumentere, hvordan man kan konstruere, implementere og evaluere et didaktisk design (Gynther 2010, 2011), hvor der arbejdes med vejlederens forskellige roller og kasketter. Ambitionen med dette projekt er at dække både planlægning, implementering og evaluering af det didaktiske design, som jeg lidt populært har valgt at kalde kasket-vejledning. Man kunne kategorisere det teori- og brugerdreven udvikling af et didaktisk design målrettet vejledning af specialestuderende (Gynther 2010, 2011, Ravn 2010). Ovenstående har ført til følgende problemformulering:

Hvordan kan man udvikle og implementere kasket-vejledning i undervisningen af specialestuderende, og hvilken betydning har det for studerende og vejleder?

Projektdesign & Metode

Projektets kontekst

De involverede uddannelser og fag er en blanding af diverse kandidat- og masteruddannelser, idet projektet fokuserer på vejledning og inddrager en

række cases i form af vejledning af kandidat- og masterstuderende fra uddannelserne landskabsforvaltning, pædagogisk sociologi, idræt og friluftsliv samt vejledning af en potentiel eller kommende ph.d.-studerende. Udviklingsprojektet sker på Københavns Universitet i relation til min egen undervisning og praksis, men involverer også en studerende fra Aarhus Universitet, der deltager som ekstern specialestuderende i et af de forskningsprojekter, hvor jeg deltager.

Projektets faser og tidsplan

Overordnet består projektet består af fem faser (se eventuelt også Gynther (2010, 2011), Ravn (2010)):

Fase	Indhold	Tidsperiode
Reviewfase	Teori- og litteraturstudier	Marts og april
Udviklingsfase	Udvikling af det didaktiske design kasket-vejledning.	Marts og april
Implementeringsfase	Implementering af konceptet i undervisningen	April, maj og juni
Evalueringsfase	Evaluering af undervisningskonceptet	Maj og juni
Formidlingsfase	Formidling af undervisningskonceptet og projektet.	August

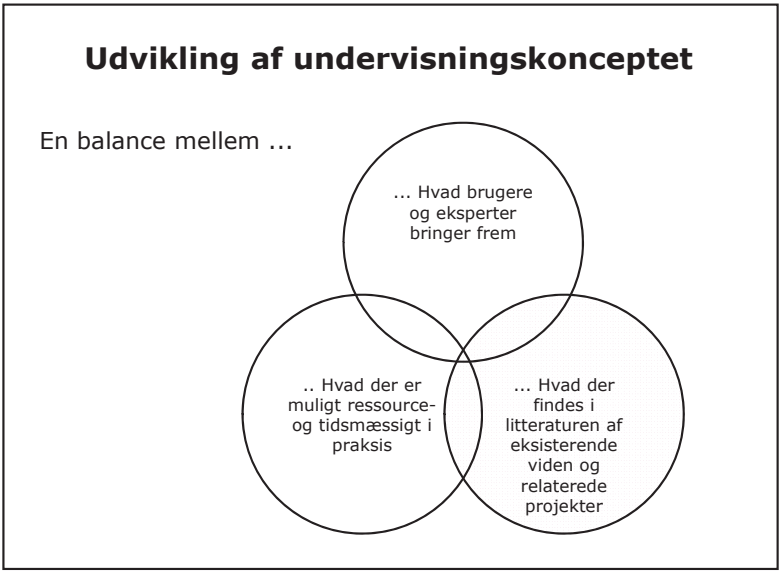
Reviewfase

I denne review-fase søges og læses litteratur om vejledning, design-based research, didaktiske design, innovation og didaktik, rollespil mm. Der er ikke tale om en klassisk og systematisk reviewproces. På grund af projektets varighed og omfang anvender jeg primært litteratur fra KNUD (især fra Ulriksens forelæsning om vejledning; Ulriksen (2012)). Jeg anvender og har tidligere anvendt design-based research i andre forsknings- og udviklingsprojekter, hvor jeg selvfølgelig også henter inspiration til metodedelen af projektet (for eksempel Qvortrup (2006), Gynther (2010, 2011), Ravn (2010)). Reviewfasen skal primært give input til introduktions- og metodeafsnittene i rapporten og sekundært diskussionsafsnittet. Reviewfasen giver også vigtige input til udviklingen af det didaktiske design kasket-vejledning: hvad siger litteraturen om vejledning, kasketter og rollespil? Hvilke kasketter og roller er ifølge teorien og litteraturen relevante?

Udviklingsfase

Som tidligere nævnt kunne man kunne kalde dette projekt for teori- og brugerdreven udvikling af et didaktisk design målrettet vejledning af specialestuderende. I tillæg til input fra teorien og litteraturen (reviewfasen)

inddrages i udviklingsfasen af projektet både speciale- og masterstuderende (en form for brugere; Qvortrup (2006), Gynther (2010)) samt min kollegasupervisionsgruppe fra KNUD (en form for eksperter). Udviklingen baserer sig således på input fra og en balancegang mellem tre fundamenter: 1) teori- og litteraturstudier 2) brugere og eksperter 3) hvad der er praktisk muligt (se figur 16.1). Se senere afsnit for en beskrivelse og diskussion af det endelige undervisningskoncept.



Figur 16.1. Udvikling af undervisningskonceptet.

Jeg vil således gennemføre en form for innovations- og udviklingsworkshop med henholdsvis brugere og eksperter. Det bliver af cirka en times varighed med et kort oplæg fra undertegnede om projektet og resultaterne fra litteraturstudiet. Herefter følger en form for fokusgruppeinterview med gruppen, hvor jeg stiller spørgsmål og faciliterer en fælles brainstorming og diskussion. Jeg håber, at få nogle værdifulde input til udviklingen af det didaktiske design kasket-vejledning, for eksempel i form af nye metaforer

og kasketter. Hvem vil de studerende for eksempel gerne vejledes af? Hvad tænker mine kollegaer? Nogle vigtige roller eller kasketter?

Jeg mener (blandt andet i forlængelse af Handal & Lauvås (2006)), at det er essentielt at involvere brugerne i udviklingen af didaktiske design. Enhver afvigelse fra den traditionelle undervisningsform kræver selvfølgelig en italesættelse og involvering for at undgå forvirring og modstand – enhver ændring i det didaktiske spil kræver en fornyelse af den didaktiske kontrakt. Hvis undervisningskonceptet skal fungere efter hensigten, bliver de studerende nødt til at acceptere det didaktiske spil og engagere i rollespillet. Og det vil denne tidligere involvering og brugerinddragelse forhåbentlig hjælpe med Gynther (2010).

23. marts 2012: Udviklingsworkshop med eksperter

Som ovenfor beskrevet afholdt jeg en udviklingsworkshop med min kollegasupervisionsgruppe den 23. marts. Workshoppen varede cirka en times tid. Jeg faciliterede og udarbejde samtidig noter undervejs. Alle deltagerne fremhævede, at de havde tænkt over deres forskellige roller i vejledningen. Flere af eksperterne havde oplevet konflikter omkring de forskellige roller, for eksempel i stil med "jeg er ikke din mor — det må du selv stå for". Andre nævnte, at de var af den opfattelse, at de ofte styrede de studerende for meget og var for målrettede på grund af eget ejerskab for projektet. Endelig havde én oplevet problemer i forbindelse med vejledning af en god bekendt eller en god kollega. Følgende kasketter kom frem eller blev foreslået: veninde eller ven, hjælper, rådgiveren, laboratoriehjælperen, engelsklæreren og skrivevejlederen. Mine kollegaer gjorde mig opmærksom på, at jeg skulle overveje om og eventuelt hvordan og hvor meget jeg kunne tillade at eksperimentere med vejledning af specialestuderende, da specialet for mange studerende er et vigtigt punktum for deres uddannelse. Mine kollegaer foreslog derfor, at jeg afsatte ti minutter til sidst til afprøvning af designet. Afslutningsvis diskuterede vi, om der var forskel på at være mor eller far som vejleder — og om der derfor var behov for en kasket mere (far) i tillæg til mor-kasketten.

23. marts 12: Udviklingsworkshop med brugere

Som ovenfor beskrevet afholdt jeg også en udviklingsworkshop med tre specialestuderende og en ph.d.-ansøger. Workshoppen varede cirka en times tid. Jeg faciliterede og noterede undervejs. De studerende var alle enige om, at det kan være problematisk med dobbeltrollen som vejleder og

eksaminator. En studerende fremførte, at man af og til godt kan føle sig lidt snydt: man troede, at man spillede på samme hold, men til eksamen havde underviseren noget i lommen. Dobbeltrollen gør, at studerende godt kan komme til at føle, at de skal sælge sig selv til underviseren i løbet af vejledningen og fremstille det positive. Flere fremhævede, at de brugte meget tid på at forberede dokumenter, der skal fremsendes til vejlederen. Flere synes, at ven-rollen ville blive for kunstig, idet de studerende godt er klar over, at man ikke er venner, og at det er en asymmetrisk relation. De studerende forventer ikke en personlig relation til vejlederen, men synes, at det er positivt, hvis det sker. Man kan godt mærke, om det er ægte. Der var lidt uenighed omkring mor-rollen. En forventede ikke denne rolle fra en underviser, mens en anden dog ville forvente omsorg og tid til at snakke, hvis man for eksempel mødte op til vejledning med røde øjne. De studerende havde valgt vejleder både efter det personlige og det faglige, men pointerede dog også, at man ikke ved, hvilken vejlederrolle underviseren vælger at have. De studerende tilføjede følgende kasketter og roller: Den positive psykolog — den positive ånd — den anerkendende pædagogik og træneren eller hepperen. En studerende foreslog afslutningsvis, at "man godt kunne have brug for at have vejledning om vejledning". Denne udviklingsworkshop var også en vigtig del i forbindelse med implementeringen i undervisningen, idet jeg fik accept fra de studerende til at benytte deres vejledning i udviklingsprojektet. De ønskede alle at deltage, men forbeholdt sig dog retten til at sige fra undervejs eller at bede om traditionel vejledning.

Implementeringsfase

I løbet af april, maj og juni 2012 implementerede og afprøvede jeg i samarbejde med de studerende (to specialestuderende og en ph.d.-ansøger; den sidste af de specialestuderende gik på barsel umiddelbart efter udviklingsworkshopen) konceptet i min egen undervisning.

Evalueringsfase

Undervisningskonceptet kasket-vejledning blev evalueret på to måder. Dels via interviews med og tilbagemelding fra studerende og dels via refleksionspapirer fra undertegnede (se venligst senere afnsit for en beskrivelse og diskussion af evalueringsfasen).

Formidlingsfase

Projektet vil blive formidlet på tre måder. For det første via KNUD-projektrapporten, sekundært på KNUD-dagen i august 2012 og endelig via denne artikel.

Koncept & Implementering

Kasket-vejledning

Her beskrives kort de didaktiske principper for kasket-vejledning, som det endte med at se ud. Beskrivelsen følger de overordnede didaktiske spørgsmål: hvad, hvorfor og hvordan (samt hvor og hvem).

Hvad er kasketvejledning?

Kasket-vejledning er et undervisningskoncept eller didaktisk design, der er udviklet på baggrund af teori og litteratur om vejledning samt input fra eksperter (deltagere på adjunktpædagogikum) og brugere (egne specialestuderende).

Hvorfor kasket-vejledning?

Kasket-vejledning implementeres i undervisningen med henblik på: – at få de studerende til at formulere, hvad de ønsker, der skal være i fokus ved vejledningen, – at få undervisere til at arbejde med forskellige vejlederroller i specialevejledningen og udvikle deres vejlederstil, – at få studerende og vejledere til at metakommunikere om og -reflektere over de forskellige vejlederroller.

Hvordan kasket-vejledning?

I de sidste 10 minutter af hver vejledning vælger de studerende en af nedenstående kasketter. Alternativt kan de studerende i deres skriftlige oplæg efterspørge en bestemt kasket til de sidste 10 minutter. Litteraturen nævner følgende kasketter eller roller (i alfabetisk og ikke-prioriteret rækkefølge):

- Angrebskasketten (Kaae 1999, s. 394)
- Arbejdsgiveren (Tofteskov (1997) citeret i (Kaae 1999, s. 384))
- Chef (Olesen et al. 2011)
- Coachen (Andersen & Jensen 2007)
- Critical friend Deuchar (2008)
- Den krakilske censor (Ulriksen 2011)
- Den skeptiske læser (Ulriksen 2011)
- Director (Deuchar (2008)
- Eksperten (Andersen & Jensen 2007)
- Facilitator Deuchar (2008)
- Flinke-kasketten (Kaae 1999, s. 397)
- Fødselshjælperen (Andersen & Jensen 2007)
- Mor (Olesen et al. 2011)
- Repræsentanten fra en anden teoriretning (Ulriksen 2011)
- Reviewer-from-hell (Ulriksen 2012)
- Træneren (Handal & Lauvås 2006, Kaae 1999, s. 55,s. 388)
- Ven (Olesen et al. 2011)

Eksperter og brugere nævnte på de to udviklingsworkshop følgende kasketter eller roller (i alfabetisk og ikke-prioriteret rækkefølge):

- Censoren
- Dansklæreren
- Engelsklæreren
- Den positive psykolog (den positive ånd – den anerkendende pædagogik)
- Forlæggeren
- Laboratoriehjælperen
- Rådgiveren
- Skrivevejlederen
- Træneren/hepperen (delvis gentagelse fra litteraturen)
- Ven (gentagelse fra litteraturen)

Hvor og med hvem implementeres kasket-vejledning?

Kasket-vejledning afprøves i samarbejde med to specialestuderende og en ph.d.-ansøger (alle kvinder) i foråret 2012 på Københavns Universitet i forbindelse med vejledning af deres specialer og ph.d.-ansøgning.

Implementering

19.04: Vejledning med ph.d.-ansøger inden for uddannelsesforskning

Den studerende valgte at blive vejledt af den kritiske ven de sidste 10 minutter af vejledningen. Hun skulle aflevere sin ph.d.-ansøgning til ekstern bedømmelse en måned efter denne vejledning og havde behov for nogle kritiske perspektiver inden den sidste slutspurt og afslutningsfase.

18.05: Vejledning med specialestuderende fra landskabsforvaltning

Den studerende valgte at blive vejledt af coachen de sidste 10 minutter af vejledningen. Denne specialestuderende var ca. tre måneder inde i sit projekt og skulle til at generere sin empiri gennem en række observationer af og interviews med skoleelever.

22.05: Vejledning med specialestuderende fra sociologi

Den studerende valgte at blive vejledt af metode-eksperten de sidste 10 minutter af vejledningen. Denne specialestuderende var ca. tre måneder inde i sit projekt og skulle til at generere sin empiri gennem en række observationer af og interviews med skoleelever. Som oplæg til vejledningen havde den studerende fremsendt et udkast til metodeafsnittet.

12.06: Vejledning med specialestuderende fra landskabsforvaltning

Denne vejledning blev anderledes end forventet, idet den studerende mødte op og var meget fortvivlet og ked af det. Hun var i tvivl, om hun kunne nå at blive færdig til tiden. Hun have en stram deadline og manglede at skrive store dele af specialet. I fællesskab lavede vi en tidsplan med milepæle og deadlines. På grund af situationen og hendes humør blev der ikke anvendt nogle kasketter til denne vejledning.

29.06: Vejledning med specialestuderende fra sociologi

Den studerende valgte at blive vejledt af den krakilske censor de sidste 10 minutter af vejledningen. Den studerende var næsten færdig med specialet og havde cirka 14 dage til aflevering. Hun havde fremsendt tekstuddrag fra specialeudkastet.

Evaluering & Diskussion

Evalueringen og tilbagemeldingerne i forbindelse med dette case-baserede udviklingsprojekt er overvejende positive. Tilbagemeldingerne fra de studerende og mine egne refleksioner peger på, at kasket-vejledning har en række styrker i forhold til at italesætte de studerendes behov og ønsker. Samtidig peger flere af de studerende på, at projektet igangsatte metakommunikation og -refleksion omkring de forskellige vejlederroller og -behov. Min oplevelse var stort set den samme. Jeg fik mange gode samtaler med de studerende, og jeg fik samtidig gjort mig nogle overvejelser omkring min egen rolle som vejleder.

Hvis det havde været tids- og ressourcemæssigt muligt, ville jeg gerne have arbejdet med konceptet over en længere periode og over flere vejledningsgange. Det blev også fremhævet af de studerende, blandt andet at en gang med kasket-vejledning var for lidt til, at de rigtig kunne udtale som om undervisningsdesignet. Jeg kendte de studerende rigtig godt i forvejen (blandt andet fra tidligere opgaver og projekter), og det tror jeg har været vigtigt for projektets udvikling, implementering og tilsyneladende positive modtagelse. Det er ikke sikkert, at studerende ville godtage rollespil og kasketter med en helt ny vejleder.

Hvis jeg havde tid til at gennemføre flere iterationer og design eksperimenter i relation til kasket-vejledning, så ville jeg begrænse antallet af kasketter til for eksempel 3-5 stykker med et bredt udvalg, der ikke overlapper for meget, for eksempel en positiv og rosende, en negativ og kritisk, en opmuntrende og coachende, en ekspert der er faglig og en procesorienteret. Man bør tilpasse kasketterne til den enkelte vejleder (og studerende). Jeg ville nok i næste afprøvning og implementering også indføre et element, der gjorde det muligt for vejlederen at tage kasket-valgene en gang imellem, for eksempel hvis hane eller hun oplevede eller selv havde et vist behov for en bestemt kasket eller rolle.

I litteraturen (se blandt andet Handal & Lauvås (2006), Kaae (1999)) diskuteres det, om det overhovedet er muligt for vejlederen at skifte rolle og stil. I den forbindelse er det vigtigt at være opmærksom på, at "En vejlederrolle er ikke som en frakke, man kan tage af og på. Det er noget man er, og frem for at prøve at leve op til idealiserede funktionsbeskrivelse, må man vedkende sig sin personlighed, sine fortrin og mangler, og prøve derudfra at udvikle sig igen vejlederrolle, hvor man kan finde sig selv, samtidig med at man prøver at støtte gruppen efter bedste evne" (Illeris 1985, citeret i (Kaae 1999, s. 383)). Jeg mener dog, at kasket-vejledning kan være

én måde, hvorpå vejledere kan opdyrke "et visst repertoar av strategier og metoder for å kunne være fleksible." (Handal & Lauvås 2006, s. 53).

Det er dog vigtigt at være opmærksom på dette udviklingsprojekts og undervisningskonceptets styrker og begrænsninger. Overordnet set er det mere udvikling end forskning, og der er mere fokus på innovation og implementering end evaluering og dokumentation. Projektet har således mere ført praktiske handlinger end teoretiske landvindinger med sig.

Undervisningskonceptet bør derfor mere opfattes som et udkast end et færdigt og afprøvet produkt (hvis sådan noget overhoved findes inden for pædagogik og undervisning?). Set i bakspejlet burde implementeringsfasen nok have varet længere, så der havde været mere tid til at eksperimentere, afprøve og gennemføre idéerne i et helt specialeforløb, så alle faser i specialeprocessen kunne have været inkluderet, for eksempel opstart, empiriindsamling, analyse og formidling. Implementeringsfasen burde nok også have involveret flere vejledere og under alle omstændigheder flere studerende (og flere vejledningsgange med de implicerede studerende).

Måske har det været for ambitiøst at ville beskæftige sig med både udvikling, implementering og evaluering af et undervisningsforløb i så kort en tidsperiode og forholdsvis lille projekt? Man bør nok også stille sig kritisk overfor rekrutteringen af de deltagende studerende. Der er selvfølgelig en form for bias i valg af vejledertype og personlighed, for eksempel har de deltagende studerende nok valgt mig blandt andet på grund af min personlighed og vejledertype (og er derfor måske mere positive over for idéerne om kasketter, rollespil og metakommunikation og selve undervisningskonceptet end andre studerende).

Endelig vil jeg pointere at lige så konceptuelle og strukturerede at selve beskrivelsen af undervisningsforløbet måtte virke på skrift i denne opgave, lige så fleksibelt og dynamisk er det tænkt implementeret og anvendt (jf. Kaae (1999)). I forlængelse heraf bør undervisningsforløbet selvfølgelig løbende udvikles (flere iterationer og design eksperimenter) og tilpasses den lokale kontekst og underviser (jf. den reflekterende praktiker). Således er en af de vigtigste erkendelser inden for pædagogik og undervisning måske opfattelsen af læring som et socio-kulturelt fænomen. Læring finder aldrig sted i et tomrum, men er altid situeret og kontekstualiseret (se for eksempel Lave & Wenger (2003)). Det vil sige, at læreprocesserne er infiltreret i eller vævet ind i en historisk, kulturel og fysisk kontekst. Et stadig tilbagevendende tema i pædagogikken er derfor en eksplicit fokusering på læring og kontekst. I forlængelse heraf er det vigtigt, at være opmærksom på, at det beskrevne didaktiske design kun er én måde at forsøge at udvikle

praksis på. Det findes mange andre. Konceptet skal selvfølgelig tilpasses den lokale kontekst, underviser og studerende.

Konklusion & Perspektivering

Jeg beskrev indledningsvis et behov for et pædagogisk udviklingsprojekt, der sætter fokus på metakommunikation om vejledning og de forskellige vejlederroller i et didaktisk perspektiv med henblik på at udvikle en bedre praksis inden for vejledning af specialestuderende. Ved at arbejde med forstående, handlingsorienterede og transformative forsknings- og udviklingstyper i et kvalitativt forskningsdesign i tæt samarbejde med studerende og kolleger fra adjunktpædagogikum har jeg således forsøgt at udvikle og forbedre min egen vejledningspraksis (og kontekstbaseret teori herom). Jeg har således udviklet, implementeret og evalueret det didaktiske design kasketvejledning, hvor der arbejdes med vejlederens forskellige roller og kasketter. Ved at reflektere over og diskutere det specifikke didaktiske design kasket-vejledning har jeg forsøgt at illustrere, hvordan studenteraktiverende undervisningsformer og fagdidaktiske og pædagogiske overvejelser kan bidrage til et øget læringsudbytte for de studerende.

Kasket-vejledning, som det blev udviklet og implementeret, bestod kort fortalt af, at studerende i forbindelse med deres specialevejledning kunne vælge at blive vejledt i de sidste 10 minutter af en valgfri kasket eller rolle, for eksempel træneren, coachen, revieweren from hell og den positive psykolog. Evalueringen og tilbagemeldingerne fra studerende og undervisер peger på, at konceptet har en række styrker i forhold til at italesætte de studerendes behov og igangsætte metakommunikation og -refleksion omkring forskellige vejlederroller og -behov blandt underviser og studerende. Det er dog samtidig vigtigt at være opmærksom på, at kasket-vejledning kræver tid og tillid. Der bør arbejdes med kasket-vejledning over en længere periode og underviseren bør opnå accept fra de studerende til at implementere idéerne om rollespil og kasketter. Det er nok også en god idé at begrænse antallet af kasketmuligheder, så mulighederne og valgene ikke bliver for uoverskuelige. Endelig bør kasketterne også tilpasses den enkelte vejleder (og de studerende). Det ser ud til, at der af og til er behov for, at underviseren tager kasketvalgene.

Afslutningsvis kan der i et metaperspektiv med udgangspunkt i projektet argumenteres for, at pædagogik, undervisning og læring er noget, man bør og skal eksperimentere med og løbende udvikle. Således er der et behov

for et øget fokus på didaktik, innovation og udviklingsprojekter, bruger- og studenterinvolvering (såkaldt voice of the user or customer) samt flere frie valg og indflydelse på undervisning fra de studerendes side.

Perspektivering

På trods af at jeg lidt populært har kaldt kasket-vejledning et koncept, så er kasket-vejledning langtfra et færdigt undervisningsforløb. Der skal — som i al anden undervisning — løbende udvikles, reflekteres, ændres og justeres. Undervisning, læring og pædagogik er komplekse fænomener, der skal tilpasse den lokale kontekst. Næste skridt kunne være, at andre undervisere afprøvede kasketvejledning (og tilpassede det til deres undervisning). Måske kunne idéerne også benyttes på andre former for undervisning, for eksempel forelæsninger og regneøvelser? Rollen som den rolige tavleunderviser eller den spørgende regneinstruktør kunne afprøves. Måske kunne det give inspiration til en række benspænd i kollegavejledning og de praktiske og teoretiske dele af Adjunktpædagogikum? For eksempel når de forskellige gruppearbejder skal fremlægges, eller når den enkelte adjunkt eller postdoc skal observeres. Jeg ser også en række muligheder i forhold til udvikling af egen min underviserrolle, for eksempel den tålmodige, langsomt talende underviser (jeg har en tendens til at blive for ivrig og tale for hurtigt, når jeg underviser). Kaae (1999) fremhæver i den forbindelse også, at vejledere kan benytte bryd dit eget mønster som en af flere kommunikationsformer og værktøjer i vejledningen.

Pædagogik, undervisning og læring er besværligt, rodet og komplekst. Jeg tror ikke, at en samlet operationel definition af god specialevejledning er mulig (eller for den sags skyld ønskværdig). Dette projekt er udarbejdet og skrevet med henblik på at opfordre til refleksioner, overvejelser og konkret afprøvning i praksis. Der foregår rigtig meget god vejledning rundt omkring på landets højere læreranstalter, men jeg foreslår, at vi bliver ved med at tænke, reflektere over og debattere vejledning, samt ikke mindst eksperimentere og forsøge i praksis. Der findes nok ikke én simpel, hurtig eller universel løsning. Men vi må blive ved med at forsøge. For dem, der tror på vejledning, kasketter og rollespil, er der vigtigt arbejde forude.

Part V

Course structure analysis – constructive alignment

17

Aligning theory and practice in a museum course

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Introduction

Academic museum studies programmes are frequently criticised for being divorced from the practice that takes place in museums (Dubuc 2011, Duff et al. 2010, Teather 1991). This decoupling of theory and practice was also noted locally in the student evaluation of the course *Museumsformidler* that is the object of the present account.

One issue that contributes to the decoupling of museum theory and practice in academia is the perception of the field of museum studies. To some, museum studies is not a discipline in itself, but rather a field in which different disciplines are applied, e.g. chemistry in the case of conservators, archival and legal skills in the case of registrars, and content expertise in the case of curators (Cole 1996). In this perspective, the term museum studies describes training in any or all aspects of museum practice (Desvallées & Mairesse 2005), and accordingly, there is no overarching theoretical framework which can be studied and applied in museum studies programmes, but rather a tacit and fragmented collection of literature which is difficult to synthesise or even access by practitioners and researchers alike.

Others take a more normative perspective, stating that it is precisely the fragmented nature of the literature that causes the misconception that the museum studies field lacks a foundation of knowledge and a corresponding academic identity (Silverman et al. 1996). In outlining their vision of a multidisciplinary curriculum for museum studies, these researchers divulge their perspective of museum studies as the academic analysis of museum history, theory and practice, drawing from related disciplines such

as art history, history, sociology and anthropology, cultural studies, leisure studies, etc. (McCarthy & Cobley 2009). However, museum studies programmes that take this more academic perspective may involve the use or production of overly theorized work with little or no relationship to professional museum issues (Teather 1991).

A central problem in this discussion seems to be that the sort of knowledge that is required in order to participate in the museum community is difficult to acquire in the formal setting of a classroom. Instead, one might employ what Lave & Wenger (1991) refer to as legitimate peripheral participation: legitimate, because anyone could potentially be a member of what Lave and Wenger call the community of practice; peripheral, because participants are not central but are on the margins of the activities in question; and participation, because learners are acquiring know-how and know-why through their involvement with it. In this perspective, knowledge is not a product but a process that takes place in interaction with the community of practice and is validated by the curriculum of this community. Relevant theoretical knowledge emerges through practical participation and subsequent reflection (Flowerdew 2000).

In the present case, the conjecture is thus that a successful museum studies course would involve the induction of course participants into the community of practice that carries out museum education activities in vivo. In the following, I briefly describe the *Museumsformidler* course and outline how the notion of legitimate peripheral participation guided the re-design of this course. Finally, I offer some preliminary results on the outcomes of the re-design and suggest some implications.

Object of study

The *Museumsformidler* course is a nine-week, 7.5 ECTS optional course offered by the Department of Science Education (University of Copenhagen) for all students in the sciences and humanities who have passed 60 ECTS points. There are no other prerequisites, although there is a recommendation that participants have taken the Department's Science Communication and Dissemination course. The typical participant is a bachelor's degree student within the sciences ranging from little or no experience to some experience with communicating and disseminating science. The goal of the course is to introduce students to the theory and practice of the dissemination of science content to various audiences through different

museum media. The course is targeted towards students who wish to gain present or future employment at museums (Mortensen 2012).

The evaluation of the 2011 implementation of the course indicated that overall, the participants were satisfied with the course, but felt that the theoretical aspects of the content could be strengthened (Mortensen 2011). Particular comments were: "a better linkage between theory and practice would have been good"; "I think the practical cases should be accompanied with concrete theory"; "too wide a gap between theory and practice"; "I still have trouble linking the theory with what we learned in practice"; and "[the course] could have been more theoretical". Accordingly, the course seemed a promising candidate for re-design from the perspective of legitimate peripheral participation.

A framework for course design

The framework I use here is based on the interdisciplinary approach to course design presented by Mavor & Trayner (2001). This approach consists of (1) an analysis of a professional community of practice; (2) an identification of relevant practices and corresponding genres which represent that community; and (3) a constructive alignment of a higher education course with these practices in order to create a learning experience which can produce professionally relevant competencies.

Accordingly, the first step I take is to characterise the community of practice that consists of professional museum staff engaged in the dissemination of science. The next step is to identify possible practices and dissemination genres that represent that community. Finally, I integrate these practices and genres in the teaching and learning activities and assessment of the *Museumsformidler* course in order to generate more well integrated and appropriate learning opportunities.

Characterising the community of practice

To identify the practices that characterise science dissemination teams in Danish museums, I distributed an online questionnaire to 113 science dissemination staff members of twenty-six museums and other informal science education institutions in February 2012 (see Appendix A for a complete list). The questions were based on the premise that dissemination staff makes up communities of practice (Hansen et al. 2004) which have a shared

repertoire that defines their practice. This repertoire includes the concepts, language and tools of the community of practice which have accumulated over time, and which define the framework within which the community's practices take place (Wenger 2000). Accordingly, the questionnaire was shaped around the notion of repertoire and how this repertoire is expressed in the activities and products of the community of practice in question. I received 53 responses to the questionnaire[1]. It is beyond the scope of this text to report the results in full, but some important findings are:

- The most frequently reported science dissemination activities among museum staff are developing and implementing programmes for visiting school groups (40 % of respondents), developing and implementing exhibitions (36 %), and developing and implementing other types of oral dissemination activities using objects or specimens for casual visitors (11 %).
- The most important resources for museum staff when developing dissemination activities are visits to other informal science institutions (62 %), experience-sharing with colleagues (53 %), and reading relevant journals (21 %). These resources provide a shared repertoire for group members when they develop activities.
- Often, team members (who typically represent a variety of backgrounds) are not in agreement initially on the objectives of the development work, but as the work proceeds, a general consensus is reached.

Representative practices and genres

On the basis of the results, it was decided to focus on three genres of science dissemination in the *Museumsformidler* course, namely school programmes, exhibition or exhibit development, and other oral dissemination activities. These three genres became the backbone of the course in that the exercises as well as the two written assignments consisted of the development of and/or the reflection upon cases within those three dissemination genres.

Furthermore, it was decided to involve as many actual museum staff members and settings as possible in order to create opportunities for participants to experience and participate in the real problems of museum science dissemination. Post-lectures and exercises were provided in every case in

[1] Questionnaire available at https://docs.google.com/spreadsheet/viewform?pli=1&formkey=dFprV052Tlc5UTl2c0g0Q29WdnBwNWc6MA#gid=0

order to facilitate participants' reflection and help them generate structure and meaning of the knowledgeable skills they derived from these opportunities (Duff et al. 2010, Flowerdew 2000, Lave 1991) . Literature for these post-lectures and exercises was in all cases chosen based on the real-life scenario at hand. Finally, all the course lessons were held in authentic settings: Experimentarium, Danmarks Akvarium, Statens Naturhistoriske Museum, Københavns Zoo, and Geocenter Møns Klint.

Finally, it was decided to include as much group work as possible in the course in order to promote the creative tension reported by museum staff. This creative tension and the critical reflection that it can promote are valuable for understanding shared experiences in groups of peripheral participants (Buysse et al. 2003).

Constructive alignment

Constructive alignment is the reciprocal calibration of the stated objectives, the teaching and learning activities, and the assessment of a given course (Biggs & Tang 2007). In the case of *Museumsformidler*, the course objectives were fixed by the time this work was under way, so the constructive alignment consisted of calibrating the teaching and learning activities and the assessment against the stated objectives. These objectives were for participants to acquire the ability to:

1. Delimit and transform a scientific content to various dissemination situations in accordance with the objects, exhibits and other artefacts that comprise the situation in question.
2. Evaluate different dissemination tools in relation to the audience's prior knowledge, developmental stage, and other characteristics.
3. Plan, carry out, and evaluate own dissemination activities as well as those of others in various situations, using the tools presented during the course.

The teaching and learning activities were aligned with the course objectives in that the dissemination situations and dissemination activities mentioned in points 1 and 3 in the objectives were consistently and explicitly described by the course instructors in terms of the three genres of science dissemination (school programmes, exhibition or exhibit development, and other oral dissemination activities). These three genres were emphasised as the pivotal activities of museum dissemination, and both the exercises and

written assignments during the course as well as the written exam assignment were framed in terms of those three genres.

Furthermore, the tools mentioned in course objectives 2 and 3 were consistently and explicitly described by the course instructors in terms of the theoretical concepts developed and discussed during the various teaching and learning activities. Course exercises were specifically aimed at applying the tools to real museum practice, and the formulation of both the written assignment questions and the exam assignment question specifically mentioned the importance of using these tools in the development of and reflection upon the chosen dissemination activity.

Outcomes of the course re-design

In order to gauge the effects of the re-design of *Museumsformidler*, a formative assessment was carried out. In this assessment, participants were asked to anonymously construct a personal meaning map of the concept of science dissemination in museums on three separate occasions during the course. The first map was constructed during week one (of seven weeks' instruction), the second during week four, and the third during week seven. The idea was to track each student's progression during the course and to assist students' reflections upon their progression. In weeks four and seven, the participants were given their earlier personal meaning maps as a support for their new map, and were free to change or ignore the old map in constructing the new one. I collected three maps from each of nine participants, two maps from each of five participants, and one map from each of four participants, a total of 41 personal meaning maps. Here, the focus is on the progression of the nine students who handed in three maps each.

Preliminary analysis of the concept maps (Fig. 17.1) shows a satisfactory development in the extent, breadth, depth, and mastery (cf. Falk et al. (1998)) of participants' understanding of the concept of science dissemination in museums as it was framed and presented in the course. Of these scores, the mastery score is of particular interest to the case at hand, because mastery measures the change in the participants' mastery of the concept of science dissemination in museums which is an indication of how well they incorporate theoretical concepts into their personal meaning-making. The preliminary results indicate that the participants do not quite achieve mastery of science dissemination in museums although they do progress from their novice starting point.

	Extent (mean number of concepts used)	**Breadth** (mean number of concept categories used)	**Depth*** (degree of detail in category; score 1-4)	**Mastery*** (facility with which understanding is described; score 1-4)
Map 1	11.1	4.6	1.1	1.0
Map 2	22.8	6.1	2.1	1.9
Map 3	28.0	7.1	3.1	2.9

*Depth and mastery are calculated for three select categories only

Fig. 17.1. Four measures of concept learning: extent, breadth, depth, and mastery of nine participants in the course *Museumsformidler*.

This assessment is supported by the distribution of marks for the exam in the course (Fig. 17.2), which, together with my impressions as the examiner, indicate that the participants in the course achieved some proficiency with the interplay between theory and practice in museum science dissemination, but did not, on average, achieve complete proficiency.

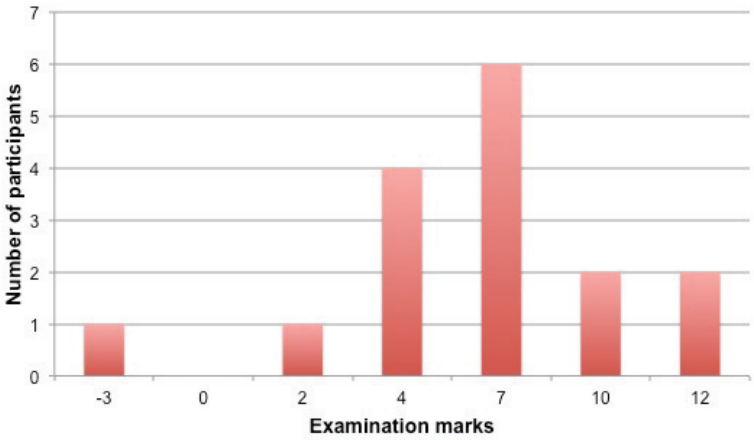

Fig. 17.2. The distribution of marks at the final exam of the course Museumsformidler. A total of 15 students took the exam. The mean score is 6.5.

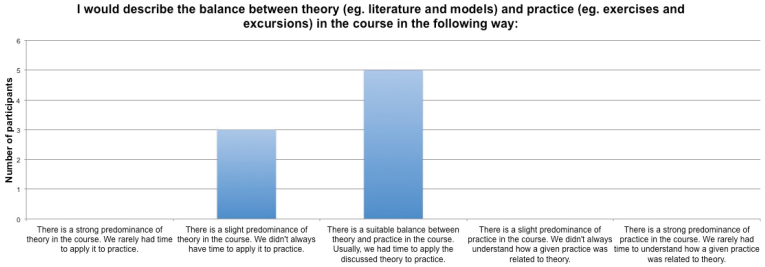

Fig. 17.3. Participants' responses to the prompt: "I would describe the balance between theory (e.g. literature and models) and practice (e.g. exercises and excursions) in the course in the following way:". The evaluation was carried out after the exam. A total of eight participants responded.

Participants' own impressions of the interplay between theory and practice are expressed in figure 17.3, where they evaluate the balance between the theory and practice in the *Museumsformidler* course. Overall, participants found that there was little or no predominance of theory over practice in the course.

Discussion

In this text, I have outlined how a re-design of a course about science dissemination in museums was planned, implemented, and assessed. The pivotal notion of this re-design was the idea of legitimate peripheral participation as presented and discussed by Lave & Wenger (1991). Two principles are central to this perspective: (1) knowledge is situated in experience, and (2) experience is understood through critical reflection with others who share this experience (Buysse et al. 2003). Theory is produced in this critical reflection by learners as they experience specific practices (Wenger 1998). The approach was thus deemed a suitable remedy for the disconnect between theory and practice for which courses and study programmes with museum-related content are commonly criticised (Dubuc 2011, Duff et al. 2010, Teather 1991).

Although legitimate peripheral participation in the museum community is central to the chosen approach, there is still a place for formal instruction

in the course. Indeed, classroom time can be though of as an opportunity for facilitating and reflecting upon legitimate peripheral participation as opposed to an opportunity for the transmission of knowledge (Flowerdew 2000). In the present case, classroom time seemed to work particularly well in this respect as evidenced by this comment from the course evaluation:

> The presented theory and the on-going exercises have been so efficient that many concepts have been understood through the classroom lessons – we almost didn't need to read the course literature (Anonymous participant in Museumsformidler, 2012).

Although there are some indications that participants in the re-designed course found a better connection between theory and practice than the participants in the original design, there is room for improvement as evidenced by the formative and summative assessment of the course. However, the modest success of the re-designed course emphasises the merit of the legitimate peripheral practice approach, and perhaps validates the notion that theory and practice should not be seen as dichotomous educational goals in museum courses but rather as reciprocal processes of practical experience and critical reflection embedded in real-life settings.

A The online questionnaire was sent to staff from science education institutions

The questionnaire was sent to dissemination staff members of the following institutions:

1. Statens Naturhistoriske Museum
2. Naturhistorisk Museum Århus
3. Naturama
4. Teknisk Museum Helsingør
5. Jagt og Skovbrugsmusset
6. Kroppedal Museum
7. Geocenter Møns Klint
8. Experimentarium
9. Danfoss Universe
10. Økolariet Vejle
11. Tycho Brahe Planetarium
12. Medicinsk Museion
13. Steno Museet (+ Botanisk Have Århus)
14. Sønderjyllands Museum
15. Kattegatcenteret
16. Nordsømuseet
17. Fjord & Bælt
18. Danmarks Akvarium
19. Fisker- og søfartsmuseet Esbjerg
20. NaturBornholm
21. Fur Museum
22. Københavns Zoo
23. Givskud Zoo
24. Odense Zoo
25. Aalborg Zoo
26. Knuthenborg Safaripark

18

Towards constructive alignment of the interdisciplinary land use and natural resource management course

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Introduction

For the past three years I have been part of the team of lecturers of the MSc course, "Interdisciplinary Land Use and Natural Resource Management" (ILUNRM). In an earlier essay as part of the university pedagogic course (*Adjunktpædagogikum*), I have attempted an assessment of the level of constructive alignment (cf. Biggs & Tang 2007) of the ILUNRM course. The assessment points towards significant room for improvement in relation to aligning intended learning outcomes (ILOs), training and learning activities (TLAs) and assessment tasks (ATs), cf. Hansen (2012). The present paper attempts to address more specifically how the course could be further constructively aligned to facilitate deep learning, i.e. how to improve the constructive alignment of the ILUNRM course. The specific objectives of the study are to: (i) to consider what ILOs developed in the Structure of the Observed Learning Outcome (SOLO) taxonomy may look like; (ii) to discuss revisions to the TLAs vis-à-vis the suggested ILOs; and finally (iii) to discuss how the assessment tasks could be revised. Apart from own experiences from the course, the study draws on the students' evaluation of the course, and views of the teaching team. I hope that the report can provide the background for continued discussions in the lecturing team for further development of the ILUNRM course.

Background

ILUNRM is a 15 ECTS M.Sc. course at the Faculty of Science. It is implemented in one block (Block 3), i.e. the students do not have other courses in that block. The course is followed by more than sixty students each year from a host of MSc programmes at University of Copenhagen (UCPH) and Roskilde University (RUC), including Agricultural Development (UCPH), Sustainable Tropical Forestry (UCPH), Anthropology (UCPH), Geography (UCPH), Geography (RUC) and International Development Studies (RUC). It follows that the students have very diverse disciplinary backgrounds (both natural and social sciences). Moreover, the students are a culturally diverse group with more than fifteen nationalities represented in the 2012 course.

The course is problem-based in the sense that the students, in groups, work on real-life assignments in a natural resource and developing country context. This year (2012), the students worked on assignments in Kenya and Malaysia. I participated in the Kenya trip, where students divided into four groups studied water issues, crop production systems, energy and fire wood issues and livestock production, respectively; each group working in the setting of a specific village. In the field, the students work with students from a local university; this year in the Kenya case, students from the University of Nairobi.

The course structure currently involves a 3.5 weeks preparatory phase in Denmark with lectures and exercises where students work on a synopsis that describes the problem and how they will address it. This is followed by two weeks of supervised field work and data collection in a developing country. Upon return from the field, there is a supervised data analysis and report writing phase of three weeks. The assessment is an individual oral examination with point of departure in the report.

Methods and material

The study draws on my personal experiences and reflections from being a lecturer on the course. Second, I have included students' evaluations of the course. Third, I have tried to incorporate the views and ideas of other members of the lecturing team. With regard to the students' evaluation, the 2012 course was only evaluated by a few students due to some technical problems with Absalon (the course homepage) at the time of evaluation.

I have therefore included the evaluation of the 2011 course as well. I did not lecture in the 2011 course, but it was very similar to the 2012 course, and hence the evaluation is believed not to differ significantly from what would have been the case should the 2012 evaluation worked as expected. In the evaluation, I have mainly made use of the qualitative part; and present results as a number of selected quotes. The evaluation is a mix of English and Danish. For clarity, I have chosen to present the quotes in Danish in their original form rather than to attempt to translate them. As for the views of fellow lecturers, a half-day workshop was implemented in the team of lectures (six participants), where I presented an assessment of course ILOs, TLAs and ATs as an introduction for a discussion. The workshop took place on 7 May, 2012. Fellow lecturers have been invited to comment on the analysis and ideas presented in this report. Nevertheless, the present essay obviously presents my personal views and ideas, which may not necessarily (fully) accord with the other members of the lecturing team.

Results and discussion

Intended Learning Outcomes

I have analysed the intended learning outcomes (ILOs) of the course in my previous essay (Hansen 2012). There I concluded that (i) the verbs used in the current seven ILOs are not in accordance with the SOLO taxonomy; (ii) the used verbs refer – probably against their intension - to lower levels in the hierarchy of verbs (uni-structural and multi-structural); and (iii) stipulated topics are unspecific, e.g. central concepts and terms within development and natural resource management (ILO no. 1).

The team of lecturers agreed to the need for a revision of the ILOs in line with the concerns raised above. Moreover, it was acknowledged that the ILOs need to feature more prominently in the course. At present the ILOs are hardly presented to the students and the ILOs are only partly guiding the Training and Learning Activities (TLAs) and the Assessment Tasks (ATs), cf. below. It is noted that none of the students reflected specifically on the ILOs in their evaluations.

In relation to the ILOs, the lecturing team discussed the central elements of the course. The following keywords capture this discussion:

- Inter-disciplinarity
- Problem-based

- Methods and analysis
- Working in groups
- Intercultural collaboration

Figure 18.1 proposes a set of revised ILOs. This is considered as a first, preliminary set of ILOs for further consideration and discussion by the lecturing team. A few remarks on the proposed ILOs: we have attempted to use only verbs from the SOLO taxonomy. Second, there is a progression from multi-structural (ILO no. 1) to extended abstract (ILOs no. 6 and 7). Third, we have attempted to address all the keywords discussed above. Note that we have not attempted to structure the ILOs according to knowledge, skills and competences as used to be a requirement for course descriptions at the former Faculty of Life Sciences at University of Copenhagen. Whether this requirement will be maintained by the new Faculty of Science remains to be seen. I do not consider such a classification useful, since in my view the three categories overlap.

No	ILOs – After completing the course, the students should be able to:
1	*Describe* and *discuss* key field data collection methods (both natural and social science methods)
2	*Integrate* own knowledge, skills and competences into interdisciplinary problem-oriented group work
3	*Construct* a research plan for investigating a real-life natural resource "problem"
4	*Apply* selected methods in the field
5	*Analyse* and *report* on collected field data
6	*Reflect* on research plan, choice of methods and reliability of collected data
7	*Generalize* and *reflect* on results observed/obtained at the case level to broader issues of sustainability, livelihood, natural resource management and development

Fig. 18.1. Proposed, revised ILOs for ILUNRM.

Training and Learning Activities

In 2011, 68 % of the students and in 2012, 88 % agreed more or less or completely that the TLAs support the ILOs. Likewise, 83 % of students in 2011 and 76 % in 2012 more or less or completely agreed that the course was good. Students in particular are pleased with:

> "Trying out methods; comparing them and their use; learning about intercultural communication; team work; exposing students to the reality of research." (2012)

> "Fantastisk kursus. Kæmpe force at arbejde sammen med folk med anden baggrund, enormt lærerigt at trække på andres kompetencer til at supplere egne, samtidig med, at man tvinges til at blive mere klar over sig selv og sine kompetencer ift andre og hvad man fagligt og personligt kan bidrage med. Det medfører ofte at måtte argumentere for sit synspunkt, i stedet for at det er et givet udgangspunkt! Og helt fantastisk at lave research i en virkelig kontext, samtidig med at man bor og arbejder intensivt sammen med sin gruppe" (2011).

The course makes use of the following TLAs:

- Lectures
- Exercises
- Student-led presentations
- Supervised group assignment, which may be sub-divided in
- Synopsis
- Field work/data collection
- Analysis and report writing

Lectures

> "Forelæsningerne var alt for komprimerede og overfladiske. De der handlede om velkendt stof var ren gentagelse; dem der handlede om ukendt stof var for hurtige og overfladiske til at jeg kunne følge med. Ingen af delene er specielt hensigtsmæssigt" (2011).

This quote summarizes in a sense the challenge this course faces in accommodating students from diverse backgrounds. The lectures are of two kinds: Lectures on methods (introductions to methods which are subsequently the subject of exercises) and thematic lectures. The challenge is most pronounced in relation to the thematic lectures. Some of these are of a general nature, e.g. the thematic lectures on land tenure, governance, gender and conflicts, and sustainability, which beg questions as to their specific relevance. Likewise, these are topics where the prior knowledge of the students varies from nothing to highly detailed.

There appears to be a general agreement among the lecturers that there is a need to reconsider (some of) the thematic lectures. The way forward could include turning some of them into introductory lectures and develop exercises linked to the lectures. This model could be applied in relation, for example, to the lectures on sustainable livelihoods and rural economies, sustainability, and nutrient flows in farming systems. Moreover, there is a

need to develop introductory lectures on how to work in groups and om interdisciplinarity. This is also reflected in the students' evaluations, e.g.:

> "Idet kurset baserer sig på gruppearbejde mellem danske og udenlandske studerende mener jeg, der burde have været mere fokus på processen i at arbejde i grupper. Alle de udenlandske studerende i min gruppe har aldrig før arbejdet i grupper, hvilket har givet anledning til nogle interne misforståelser, men medfører endvidere at der gentagende er tvivl blandt dem om, hvilke krav der stilles, hvordan forskellige ting skal håndteres etc. Således mener jeg, at man bør sætte folk i grupper hurtigst muligt, som det også gøres nu, og derfra bruge langt mere tid på (og være langt mere tydelig omkring og opmærksom på) at beskrive og forklare hvad gruppearbejdet indebærer i hver enkelt del af opgave perioden" (2011).

> "Jeg synes at den største udfordring har været at samarbejde tværfagligt, hvor en introduktion til forskellige forskningstraditioner og videnskabsteoretiske retninger kunne have været en klar fordel. I min gruppe var det en stor udfordring at få en fælles forståelse for vores forskning, men det undrer jo ikke når de naturvidenskabelige studerende ikke har en indsigt i forskellene på de forskellige forskningstraditioner" (2011)

Exercises

The 2012 courses included a few more exercises than in previous years, and more options for students to choose between different exercises based on interest. The lecturers agree that this worked well, and is a direction that should be further pursued. The evaluations also point in this direction:

> "Generelt vægtedes de naturvidenskabelige metoder meget højere end de kvalitative metoder. Er det muligt at ændre på det? Eksempelvis var der sat 7 timer af til at lære to naturvidenskabelige metoder efter eget valg og 3 timer til at lære 3 kvalitative metoder" (2012)

> "More practical exercises on PRA methods would have been needed. The two methods tried out were good, but also raised a lot of questions which could've been addressed through additional exercises or at least sufficient time for questions and answers" (2011)

Some ideas for additional exercises are discussed above in the section on lectures. In addition, based on the 2012 reports and expressed wishes from the students, the addition of exercises on data analysis and presentation could be considered.

Student presentations

The student presentations are generally not favoured by the students as illustrated by the following two quotes:

> "De mange studenterfremlæggelser var muligvis ikke så nødvendige. Meget lidt tilslutning og ikke rigtig tid til at arbejde på (forholdsvis) ligegyldige fremlæggelser frem for synopsis" (2012)

> "Too many oral presentations without other purposes than to do it for the sake of it. When we are busy writing synopsis and fieldwork, it could feel like waste of time doing presentations that the teachers even couldn't stay awake for" (2011).

The lecturers acknowledge this criticism, including the poor quality and level of attendance of at least some of the student presentations. There is thus a need to reconsider the use of student presentations, including a possible reduction in the number, revision of topics and replacing some of them with lectures (in country groups) prepared by the lecturers.

Supervised group assignment – synopsis

Under the current course organization, the students spend approximately 3.5 weeks preparing a synopsis for their group assignment alongside the lecturers and exercises discussed above. It could be advisable to condense this part of the course somewhat in order to have more time for the data analysis and report writing. In practical terms this means that the students should submit their synopsis at the end of the third week.

> "There is a lot of time spent on the synopsis which has to get changed anyway, once the students arrive in the host country. It helps to go through a thought process but in the end it seems to be a lot of time wasted on 'what if' questions, rather than facts. Introducing some leading articles on the subject would help more to bring everybody on the same line." (2011)

In relation to the synopsis and the student comment above, the team of lecturers has also discussed the nature and quality of the problem that is presented to the students and which forms the backbone of the students' work on the synopsis. As stated above, it is generally agreed that the course is problem-based and should take its point of departure in a concrete problem on the ground. Currently, there are some differences concerning how

specific is the problem presented to the students, partly due to differences among the countries and partner universities that the course collaborates with. The lecturers generally agrees that a specific problem formulation – in contrast to a broadly defined problem area – would facilitate the students' work on the synopsis, as would background information as elaborated and detailed as possible. Both aspects point towards the need to spend more time in the field with the partner universities to prepare problem formulations and material. This said, the identified problem should obviously still be defined in a way that requires a multi-disciplinary approach using both natural and social science theories and methods.

Challenges arising because students from our partner universities have different tasks, synopsis, or even no synopses, which clearly frustrates the Danish students and the collaboration, can probably never be completely eliminated. As a minimum, we need to prepare the students better on this issue.

Supervised group assignment – field work and data collection

This part of the course generally receives favourable evaluations:

> "The project provided an opportunity to try out various data collection methods which will be useful both for thesis work and also later in life. It also gave much needed general field work experience and an opportunity to work not only in a group with different people, but a multi-disciplined one. Helped in learning the importance of group dynamics" (2011).

It is important that the students get sufficient time in the field to collect the required data; 10-12 days at the minimum, and are not disturbed by too many requirements for presentations and official gatherings during this phase. Moreover, it is important to consider the group size during the field work; over a certain threshold, say ten or around that figure, the size of the group constitutes a problem, and group dynamics are compromised.

Supervised group assignment – report writing

Both student' evaluations and lecturers point towards the need for more time for report writing. The shortening of the introduction phase (synopsis) would allow this. Moreover, it appears that there is a need to for us lecturers

to inform them in greater detail about the requirements of the reports. This should be combined with supervision on the report structure, immediately after the return from the field.

Assessment Tasks

The course description stipulates the assessment as (i) assessment of field report, and (ii) individual oral examination in synopsis, field report and course curriculum; each of the two components weighing 50%. However, the de facto assessment concerns primarily the report, and current assessment practice only to some extent assesses the curriculum of the course. This is a serious concern in relation to the learning process. Moreover, it can turn into a technical or administrative problem in case of students' complaints over assessment results, since disagreement between actual assessment practice and course description would be a problem. The team of lecturers agrees that there is a need to broaden the examination and consequently to downplay the importance of the report. The report should be the point of departure for an examination that assesses (i) theory; (ii) methods and data analysis; and (iii) reflection and perspectives (including inter-disciplinarity). The proposed ILOs are believed to support this direction. Further, we could develop rubrics with assessment criteria for each ILO as suggested by Biggs & Tang (2007). However, that appears to be complicated, and it is considered more feasible, at least for now, to maintain a more qualitative and overall assessment. Finally, we have discussed how to include the students' contribution to the group and the group assignment in the assessment, cf. ILO no. 2. An individual reflective diary that is submitted together with the group report could be an option in this regard, but my immediate reaction is that it is too time consuming for the students to handle along other requirements.

Conclusion and way forward

The current analysis, based on a review of students' evaluations, discussions in the team of lecturers and personal reflections, suggests that the ILUNRM course is not (fully) constructively aligned, and that students' learning could be enhanced through revisions of ILOs, TLAs, and ATs. The discussions among the team of lecturers suggest that there is agreement on

the general direction of revision, which is an important prerequisite for any change. It is suggested that changes be implemented in a step-by-step manner, starting with revisions to the lecture plan and the curriculum or contents of individual lectures and exercises. Upon further discussions in the team of lecturers, a subsequent step could be a revised course description. Considering the process of approval in the Study Board, this would in any case be a longer process, and probably not something that can be ready for the next implementation of the course in February 2013. In terms of key challenges in moving forward on course revisions, I would point at two: (i) lack of continuity within the team of lecturers (50 % annual turnover) and (ii) fitting the course into the curriculum of our Southern partner universities. However, both are considered as givens and outside the immediate control of the Danish lecturers.

19

Evaluation and suggestions for redesign of Basic Histology with a focus on constructive alignment

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Introduction

As a consequence of cut-backs in 2011, Basic Histology (part of the first-year veterinary course, "Cell Biology, Basic Histology and Basic Genetics") was placed in our group shortly before the start of the course. I was put in charge of organizing this part of the course and the exam. Two other teachers participated in the course. The course is an integrated part of the veterinary curriculum and the former professor had been responsible for the course for several years including course description, aims, exam form, lectures and exercises. The course consists of twelve two-hour lectures and twelve two-hour histology exercises (microscopy) with a class size of approximately 190 students. The exam is a two-hour written exam consisting of seven questions that counts for one-third of the total grade for the course. Note: The curriculum is defined by a list of intended learning outcomes (ILOs) and is not a traditional textbook-based curriculum.

Aim of project

To evaluate the current course, and to prepare a revised version of Basic Histology with focus on constructive alignment.

Methods

The project is based on student evaluations, teacher evaluations, exam results, and personal reflections and experiences. For each of the three main areas – ILOs, teaching and learning activities (TLAs), and exam form – the original version is presented followed by results of the evaluation process and a suggestion for revisions. In conclusion, the constructive alignment is evaluated for the original version of the course and the revised version.

Results and discussion

Intended learning outcomes – course curriculum

Original version

The curriculum was outcome-based, not due to pedagogical considerations but because the available textbooks were deemed either too substantial or too lightweight. The ILOs followed the course plan lesson by lesson.

Evaluation of 2011-2012

The list of lLOs was a useful tool in preparation of lectures. However, the lLOs were inconsistent – the level of detail varied substantially between topics, and for some topics there was a very strong commonality with Physiology, which is clearly outside the scope of the Basic Histology course. The phrasing of the lLOs could be improved. The verbs used were from the lower levels of the SOLO taxonomy scale (Structure of Observed Learning Outcome) (Biggs & Tang 2007), which made some of the lLOs more like check lists. It could be argued that some of the lLOs were phrased in such detail that they potentially left little room for independent thought or reflection (Andersen 2010).

The student evaluations showed that the students were very happy with the ILOs, and how they were used for most lectures. They found that the lLOs made revising for exams much easier. The course took place from November 2011 to January 2012, and the students were therefore not only novices to the subject, but also to university level studies in general. In addition, this was their first experience with not having a clearly defined textbook-based curriculum. The students did not express a desire for a more

traditional curriculum. We took on the course very late, and thus we decided to keep the lLOs unchanged due to lack of time for a proper revision. However, more problem-based ILOs were added to individual lectures as a supplement to the official curriculum during the course, but with a very clear distinction between official lLOs and supplementary ILOs. Basic Histology is a descriptive basic topic in the area of anatomy, and the subject does not automatically lend it self to deep reflections and problem solving, but it is possible to find examples from the clinics or whole-animal functionality that can form a basis for more problem-based teaching. It is always nice to receive positive student evaluations, but it is worth considering whether they in part reflect the fact that the level of detail of some of the ILOs was so high that they were more like check lists.

Suggestions for revised version 2012-2013

We have decided to keep the ILO-based curriculum based on the evaluations of both teachers and students. We have revised the list of ILOs in collaboration between the three teachers using our experiences, results from the evaluations, and suggestions from the literature (Biggs & Tang 2007, Derstine 2002). The lLOs have been aligned to the course description. Overlaps to other courses have been minimized, and the detail level has been evened out between subjects. We have attempted to optimize the phrasing and wording of the lLOs to move responsibility for learning away from the teacher and onto the students. The ILOs are still designed to follow the order of the lectures closely, and it could be argued that they are still too detailed. It would be interesting to apply more general lLOs or move towards a competency-based curriculum (Smith & Fuller 1994, Near et al. 2002). But for now we have decided to keep the outcome-based version, especially considering that the students have no prior experience with a non-textbook-based curriculum.

Teaching and learning activities

Original version

Every two-hour lecture was followed by a microscopy exercise. We are not sure which, if any, TLAs were included in the lectures in the old format. The ILOs and course description were not formulated to include defined

TLAs. In 2011-2012 we included some TLAs in the lectures, but the concept could definitely be expanded. The microscopy exercises followed a standard protocol adapted to each subject. An additional TLA was included in one microscopy exercise.

Evaluation of 2011-2012

The addition of more problem-based ILOs to selected lectures encouraged the use of TLAs including solving clinical cases (e.g., bone marrow transplant and DNA testing), reflecting on whole-animal functions (e.g., vascular system in the giraffe), and developing diagnostic skills (example: differential cell count). The students were very cooperative and motivated, and in their evaluations they highlight the TLAs.

Suggestions for revised version 2012-2013

Based on the revised ILOs the use of TLAs can and should be expanded. The TLAs from 2011-2012 are easy to implement in 2012-2013, so it will be the responsibility of my colleagues and I to pass on teaching materials (if we are not teaching the course again). It could be argued that the microscopy exercises are all a type of TLA and one additional TLA was used in the microscopy exercises last year with very positive feedback. However, emphasis should be placed on the development of TLAs for the lectures.

Exam form

Original version

The exam took the form of a two-hour written paper consisting of seven questions and exercises with three to four subquestions – no aids were allowed. The format of the questions had been standardized over past years. Each question represented a tissue or cell type usually accompanied by a histology image, and the students were asked to identify or describe histological structures. The exam was placed after Block 2 (January 2012), and the students had one additional exam during that exam week.

Evaluation of 2011-2012

The format of questions was very straightforward and did not encourage reflection or more complex problem solving. They were however very easy to score which should not be ignored when the class size is 190 or more. As a teacher it was discouraging to have tried to encourage the students to reflect on issues during the course and then test them this way. We had decided to leave the exam form unchanged for similar reasons to the unchanged lLOs (see above). An additional advantage for the students was that the exam resembled the exams from previous years, both with regards to form and degree of difficulty. The evaluation from the students was that they found the exam somewhat disappointing and unsatisfying. It has to be emphasized that the pass rate and average grade were very high and above those of previous years, so any discontent was not founded in poor performance. The students were not in agreement as to whether they had found it too easy or too quick to solve, but there was a definite impression that they would have appreciated an opportunity to show more knowledge. To ensure that the degree of difficulty had not been lowered I checked with our external examiner, who has been the examiner on the course for many years. He confirmed that the degree of difficulty was not changed. I questioned the students a little more closely, and an additional factor was that we apparently had succeeded in making the students interested in our course, potentially at the cost of the other course examined at the same time, where the pass rate was lower that previous years. An additional reflection I would like to put forward is the dilemma highlighted by our experience this year. What is the purpose of the exam? To test the students to make sure that they have acquired the desired skills and knowledge, to scare the students into studying because they know they will be tested, or to give the students an opportunity to assess whether they have the skill set required for the next courses?

Suggestions for revised version 2012-2013

Based on the revised ILOs it should be possible to move the format towards more problem-based questions. The basic skills acquired by the students in Basic Histology are very descriptive and this should definitely be tested, but a compromise could be to use the traditional straightforward structure questions but add a more reflective question at the end of each subject. It is very important that the degree of difficulty remains the same. A restructure

of the veterinary curriculum has meant that the students will be examined in three and not two courses in the exam week after Block 2, which needs to be taken into account especially when we evaluate the outcome of our changes to the exam form and the course in general.

Constructive alignment – a brief assessment

Basic Histology is a basic course in anatomy, in which the students are expected to acquire, among others, knowledge in tissue and cell structures, skills in microscopy, and competences in assessing, discussing, and describing cellular and tissue structures independently and in collaboration with fellow students (excerpts from course description 2011).

The course is part of the bachelor's degree in veterinary medicine. During the degree programme the students are expected to acquire, among others: knowledge in basic methods, structures, and principles in the core elements of the study programme, skills in utilizing basic principles, terms, and methods; skills in performing microscopy, in identifying changes to structures, in searching for and evaluating literature and references, in communicating the field to peers and the general public, and in use of information technologies; and competences in identifying and discussing veterinary issues, reflecting on scientific and ethical topics, participating in inter- and cross-disciplinary collaborations, working independently and assuming responsibility for their own actions, and to acquire new knowledge and take responsibility for their own learning (excerpts from study programme description 2011).

Basic Histology is a very small course in the degree programme, and thus its role in fulfilling the aims of the entire bachelor in veterinary medicine is minor. It must be considered more important for the course to fulfil the expectations listed in the course description, while not forgetting the overall aims.

Original version

In the course description terms like describe, identify and gain experience with are used frequently. The original lLOs used terms like describe, identify, understand and know, and the exam form and questions were designed to test this. Thus the ILOs, exam form, and type of exam questions comply with the course description. However, the listed competences, including assessing and discussing, are not implemented in either lLOs or exam form

in my opinion. In this version it is the sole responsibility of the teachers to ensure that all the aims – especially the competences – of the course are fulfilled.

Revised version

The revised ILOs still make use of the terms from the course description including describe and identify, but we have replaced the terms understand and know, and included terms like relate, explain, assess, and discuss. This will hopefully move responsibility for learning towards the students, while also implementing the competences listed in the course description. The TLAs mentioned previously will further this, but since they are not an integrated part of the course description, it will be the responsibility of the teachers to include them. The revised ILOs create the opportunity to make changes to the exam form, while still maintaining alignment between course description, ILOs, TLAs, and assessment.

Conclusions

Basic Histology has always been a relatively well-functioning course receiving good evaluations from students and good overall results regarding pass rates and average grades. However, an evaluation of the course helped us to identify a number of places, where the course could be optimized. Some changes were implemented immediately and were thus part of the course in 2011-2012, but additional changes have been suggested in this project report and will be part of the course in 2012-2013. These include a revision of the ILOs, which form the basis for the course curriculum, suggestions for TLAs mainly for the lectures but also for the practicals, and finally a change in the exam questions while staying within the boundaries of the current exam form. The revised version of the course appears to be better aligned with the course description while leaving more room for reflection and discussion. More radical changes could have been proposed, but it is an on going process and additional changes will likely be implemented when we have evaluated this version of the course.

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